Registered as a Newspaper in Ceylon

VOL. CV. No. 3
JULY TO SEPTEMBER, 1949
(3rd QUARTER, 1949)

The Tropical Agriculturist

The Agricultural Journal of Ceylon

Founded in 1881
by the late MR. JOHN FERGUSON, C.M.G.

Published by
The Department of Agriculture
Peradeniya, Ceylon.

The

Tropical Agriculturist

VOL. CV PERADENIYA, JULY–SEPTEMBER, 1949 No. 3

Page

Editorial—Cotton in Ceylon 95

ORIGINAL ARTICLES

Seed Placement of Phosphates in Paddy by D. Rhind, M. F. Chandraratne and E. F. L. Abeyratne 98

On the Value of Legumes by W. R. C. Paul 109

Progress of Cotton Cultivation in the South Eastern Division with special reference to the Village Cotton Purchase Scheme by H. A. Peiris 117

The Performance of the Salt-Resistant Paddy, Pokkali, in Ceylon by L. H. Fernando .. 124

SELECTED ARTICLES

The Science of Genetics by Alan Robertson 127

Deep Tillage by E. W. Russell 132

MEETINGS &c.

Minutes of the Meeting of the Central Board of Agriculture held on May 16, 1949 .. 136

Minutes of the 93rd Meeting of the Rubber Research Board 150

Minutes of the 94th Meeting of the Rubber Research Board 152

RETURNS &c.

Animal Disease Returns—July–September, 1949 154

Meterological Returns—July–September, 1949 157

The

Tropical Agriculturist

JULY TO SEPTEMBER, 1949

EDITORIAL

Cotton in Ceylon

THERE has been sporadic interest in cotton growing in Ceylon for many years and small-scale experiments are recorded at various times from 1903 onwards, though introduction of New World cottons occurred earlier. The indigenous cottons were varieties of *Gossypium arboreum* grown mainly in the North-Western Province. This is the common species of the Old World to which the main cottons of India, Burma, Indo-China, Siam and South China belong. It is usually a small, hardy plant giving a moderate yield of short staple, rather coarse lint. Even when improved by breeding the lint length rarely exceeds one inch and yields seldom reach those of which the New World cottons are capable. Not much interest has ever been displayed in this group of cottons in Ceylon. The initial interest appears to have been in the growing of a very high quality cotton, such as Sea Island, for export to the Lancashire market but as McCall pointed out in 1909 the market for this type was even then a limited one, so that any extension of the production could only be followed by a ruminous reduction in price. Trials were undertaken with New World cottons such as Upland or Egyptian at the Maha Illuppallama Farm from 1903 onwards with a certain amount of success, though the very discursive reports and absence of precision in the experiments make it difficult to ascertain exactly what the results were. McCall recommended that Indian varieties should be given up " because they serve no Imperial purpose and are unprofitable to the grower ". Egyptian cottons apparently yielded 130 lb. of lint, equivalent to about 4 cwt. of seed cotton per acre, a yield we would consider fairly satisfactory for that area to-day, and the opinion was expressed that it could be doubled with improved cultivation methods. Emphasis was placed on the need for line sowing and implemental tillage instead of haphazard planting in *chenas*, and proposals for irrigating the crop in *yala* were considered. The tendency for cottons to run to leaf in wet seasons or with excessive irrigations was noted, a fact with which we

still have to contend. Reporting to Lord Crewe, Secretary of State for the Colonies in 1910, the Governor, Sir H. E. McCallum, stated that in the view of Dr. Willis cotton might be profitably grown anywhere in the area north of a line extending from Negombo to Trincomalee or South of one extending from Matara to Batticaloa, areas which we know to-day from more extensive trials to be the most promising ones for this crop, " despite the great variations in the incidence of the monsoons during the last few years " as the Governor remarked in 1910 and many people continue to remark to-day. Later, in 1910, Dr. Willis, the Director of the Royal Botanic Gardens, took a rather pessimistic view of the prospects of cotton as a commercial enterprise because of the uncertainty of the weather.

In 1908 it appears the North-Western Province grew 245 acres of cotton, according to Ferguson's Directory. This cotton was probably the indigenous Asiatic species known to have been grown for a very long time in the Puttalam-Chilaw area, though it is possible some imported Western Hemisphere cotton may have been grown also. Specimens in the Herbarium of the Royal Botanic Gardens, Peradeniya, include one of " Peruvian Cotton " (*Gossypium barbadense* Linn.) from an old garden at Anuradhapura, dated 1883, Sea Island from Jaffna Kachcheri compound dated 1900, one noted as grown in the Gardens from seed from Florida dated 1888, and one of *Gossypium hirsurtum var. punctatum* (Schum.) J. B. Hutch. dated 1889. There is therefore a possibility that some of these varieties had already been taken into cultivation by 1908.

The interest in cotton seems to have waned after the first experiments but the crop was never wholly abandoned and some trials continue to have been made at various times. Between the first and second World Wars the area, all in *chenas*, seems to have reached as much as 400 acres at times but poor prices made it an unattractive cash crop. The *chena* cultivator is only interested in cotton for the money it will bring to him and it therefore follows that if he cannot find an easy and ready market when he wants it cotton will not suit his purpose. It is absolutely essential that the price be reasonably attractive and that there exist some purchasing organisation which will take the produce off his hands without trouble to him and without the purchase price suffering too much attrition before it reaches the grower. Pieris in this number describes the Agricultural Department's cotton purchasing work in the South-Eastern Division. It is on such schemes that the future expansion of cotton growing must largely depend because the farmers can easily change to alternative cash crops if they find cotton unattractive.

The cotton crop must pass through two separate processing centres before it reaches the consumer as cloth. The seed cotton must be ginned to remove the lint from the seed and the lint must be spun and woven. The requirements of the consuming public are mainly for a medium quality cloth suitable for everyday wear as shirts and sarongs, with a fairly large demand also for coarser cloth, such as towels, &c. Very fine cloth, such as lawn, finds only a limited market prepared to pay high prices. In selecting a variety for Ceylon attention has been given first to its agricultural suitability and secondly to its commercial uses. Out of a number of imported selections the Department of Agriculture has chosen the Uganda variety BP 79 for its present purpose. This cotton spins well and has less tendency to run to leaf in wet seasons. Although this cotton is suitable it is anticipated that

still better ones can be bred for Ceylon conditions and the Department of Agriculture is opening a Cotton Research Laboratory on Wirawila Farm (Hambantota District) where the main cotton breeding programme is carried out. The provision of ginneries to provide pure seed is also being undertaken. A peculiarity of the cotton crop is that when the grower sells his produce he parts with his seed at the same time. The seed required for the next crop must be returned to him from the ginnery. In commercial ginneries various lots become mixed and since cotton is freely cross-pollinated, the crop can deteriorate rapidly if precautions are not taken to provide a supply of good seed from plots specially grown and ginned to provide it. In a sense this is an advantage because full control of the seed supply can be obtained and any improved variety can be issued through the normal seed-distributing machinery. Pure seed to give a crop up to standard quality is more important than for paddy because the spinning machinery cannot handle mixed cotton successfully.

The cotton acreage in *Maha* in 1948–49 was about 2,600 acres. A crop of about 3,700 acres is expected in 1949–50, weather being favourable. Except for the areas on Government farms, which may amount to about 300 acres, all this will be a *chena* crop. Future expansion of cotton on a large scale will depend on the development of a system of dry, rotational farming as an alternative to the shifting cultivation at present practised in cotton-growing areas. There being few or no farmers conversant with a stabilized system of rotation the task of training men to adopt implemental tillage (incidentally training the bullocks and providing suitable implements also) will be a long one. It is clear, however, that only a limited expansion as a *chena* crop is possible without seriously interfering with food production. That cotton can be successfully introduced as one crop in such a system of rotation is certain, though it is a crop which permits a good deal of surface erosion if the tillage operations are not skilfully done. Cotton is usually not a crop giving a high monetary return per acre. It is suited to extensive cultivation rather than intensive, but in the hands of small owner-cultivators it is a useful money crop.

The requirement of the Island is about $12\frac{1}{2}$ million pounds of yarn equivalent to about 50 million yards of cloth. The ratio of yarn to seed cotton is about 22 to 100, so the total seed cotton requirement would be about 200,000 cwt. which, at 5 cwt. per acre, would require 40,000 acres each year or 160,000 acres in a 4-year rotation. Our present production is sufficient for only about 9 per cent. of requirements.

Seed Placement of Phosphates in Paddy

1—Preliminary Experiments on the Application of Phosphate Solutions to Seed

D. RHIND

DIRECTOR OF AGRICULTURE

M. F. CHANDRARATNA

BOTANIST & SENIOR AGRICULTURAL RESEARCH OFFICER

AND

E. F. L. ABEYRATNA

AGRICULTURAL RESEARCH OFFICER, NORTH-CENTRAL DIVISION

FERTILIZER placement attempts combining economy of fertilizers with efficacy. Methods that aim at placing the fertilizer within reach of the plant, and at avoiding losses by immobilization in the soil or by leaching have received much attention in recent years. The most extreme form of placement is that which deposits the fertilizer on the seed coat, or inside the seed by absorption from solutions. Roberts (1947) obtained striking results with seed of wheat, oats and barley soaked in solutions of dipotassium hydrogen phosphate. The concentrations tolerated varied from five per cent. in the instance of wheat to 30 per cent. for oats. On phosphate deficient soils, soaking of wheat seed in a five per cent. solution of dipotassium hydrogen phosphate gave a yield increase of 1·1 cwt. per acre for an application of only 1·4 lb./acre of $P_2 O_5$ in the soaking solution ; under comparable conditions, 64 lb. of basic slag gave an increase in yield of 1·5 cwt. Roberts results indicate that phosphate (associated with potash) was about 60 times more efficient when applied as a solution to the seed than when applied to the soil. With oats, she secured a yield increase of 8 cwt./acre for 13·6 lb. /acre of tribasic potassium phosphate (or 4·6 lb/acre of $P_2 O_5$) expended in seed soaking. This paper presents preliminary results of similar trials with paddy.

PART 1*—POT EXPERIMENTS

Experiment (1)

This experiment was set down in late *Maha*, 1948, with the pure line, *Pachchaiperumal 2,462/11.* Seed from the 1947 *Yala* crop, was soaked

* Part 1 of this communication formed the subject of a paper read at the 1948 Session of the Ceylon Association of Science. " A Note on Pre-soaking in Phosphate Solutions for Increasing Yield in Rice " by Narayanan, T. R. & Gopal Krishnan, S., 1949 has since appeared.

in the following concentrations of disodium and dipotassium hydrogen phosphates :—

Treatment No.	*Phosphate*	*Concentration Percentage*	*Duration*
1	—	Tap water	48 hours and 72 hours (two series)
2	$K_2H\ PO_4$	5	
3	do.	10	
4	do.	20	
5	$Na_2H\ PO_4$	5	
6	do.	10	
7	do.	20	

Twenty-five gm. of seed were soaked in 110 ml. of solution in each of the fourteen treatments that composed the two series.

The soil used was a yellowish brown loam from village paddy fields at Gannoruwa in the Central Province. This soil had a pH of 6·16 and was fairly satisfactory as regards phosphate (25 p.p.m.), but was very low in potash and rather low in nitrogen. After thorough mixing, 12 in. × 12 in. pots were filled with this soil, and kept in a plant cage that had wire-mesh sides and a plate-glass roof. Growth was poor ; both in this experiment and the succeeding one ; reduction in light intensity in the cage appeared to interfere with growth. Pairs of pots were sown with treated seeds at the rate of one-hundred per pot. Seedlings were later thinned to ten per pot. Seeds were sown on January 15, and the harvest was on April 30, 1948; the life period was 106 days

Effect on Germination.—Germination records are presented in Table 1. The salt solutions caused a retardation of the rate of germination, the effect increasing with the concentration of solution and duration of soaking. There was no marked effect on the final germination percentages, except in the series soaked for 72 hours, in which (as is shown in the variance analysis, presented in Table 2, of germinations percentages transformed to the inverse sine scale appropriate to binomial distributions) there was a significant reduction in final germination from 96·5 per cent. in tap water to 86·0, 80·5 and 70·5 per cent. in 5, 10 and 20 per cent. solutions of $K_2H\ PO_4$ respectively, and to 84·0, 87·0 and 82·0 per cent. in the corresponding series for the sodium salt. The effect of the treatments on germination has been a delaying of germination in all instances, the delay increasing *pari passu* with rise in concentration of the solutions. Apart from the fact that the sodium salt has depressed germination somewhat more in the 48 hours soaking, there is no appreciable difference in germination effects between the Na and K salts. The effect on final germination percentage is uncertain, and not of a magnitude to be of practical importance.

Effect on Grain Yields.—Complete grain and straw data are presented in Table 3. The analysis of variance of grain yields does not reach significance, but the separate analysis of the 48-hour series shown in Table 4 indicates a significant effect of phosphate. All the phosphate soakings, except five per cent. disodium hydrogen phosphate have given significantly higher grain yields than the control. The 20 per cent. dipotassium hydrogen phosphate was significantly superior to the 10 and 5 per cent. The 20 and

10 per cent. disodium hydrogen phosphate are significantly better than the 5 per cent. The effect of potash as against sodium is not clear. A response to potash was to be expected in this soil which is low in that nutrient.

TABLE 1

Germination percentages of Seeds soaked in Phosphate Solutions

Soaking Solution Percentage		*Duration of Soaking (hours)*	*Number of Days after sowing* 4	5	6	7	8	9
Tap water		48	69	77	86	88	89	89
K_2HPO_4	5	48	64	73	76	79	79	82
K_2HPO_4	10	48	32	56	74	78	82	84
K_2HPO_4	20	48	15	44	64	71	84	85
Na_2HPO_4	5	48	70	77	79	79	84	85
Na_2HPO_4	10	48	66	71	75	75	85	86
Na_2HPO_4	20	48	56	68	74	77	83	86
Tap water		72	73	86	96	97	97	97
K_2HPO_4	5	72	52	70	84	85	85	86
K_2HPO_4	10	72	36	59	72	77	79	81
K_2HPO_4	20	72	19	35	54	66	71	71
Na_2HPO_4	5	72	47	71	81	83	84	84
Na_2HPO_4	10	72	57	68	80	86	87	87
Na_2HPO_4	20	72	32	45	61	80	82	82

TABLE 2

Analysis of variance of percentage

Seeds germinated nine days after sowing in the 72-hour series

(Data transformed to inverse sine scale, $\theta = \sin^{-1}\sqrt{p}$)

	Degrees of Freedom	*Sum of Squares*	*Mean Square*	*Variance Ratio*	*5 per cent. Point*
Treatments	6	547·10	91·18	5·27	3·87
Error	7	121·09	17·30		
Total	13				

Percentage standard error : 6·20.

	Soaking Solution						*General Mean*	*Standard Error*	*Significant Difference*
	Tap Water	K_2HPO_4 5%	K_2HPO_4 10%	K_2HPO_4 20%	Na_2HPO_4 5%	Na_2HPO_4 10%	Na_2HPO_4 20%			
Degrees ($\theta = \sin^{-1}\sqrt{p}$)	79·7	68·0	64·2	57·3	66·4	68·9	64·9	67·05	±2·94	9·84
Percentage germination	96·8	86·0	81·0	70·2	84·0	87·0	82·0			

TABLE 3

Yields of Grain and Straw in Pot Experiment 1

Means per 10-plant pots

Soaking Solution Percentage		*Duration of Soaking* — *48 hours* Grain (gm.)	*48 hours* Straw (gm.)	*72 hours* Grain (gm.)	*72 hours* Straw (gm.)
Tap water		3·5	9·5	4·3	11·0
K_2HPO_4	5	4·2	11·3	3·9	11·9
K_2HPO_4	10	4·1	11·7	3·8	11·3
K_2HPO_4	20	4·7	11·7	4·5	12·7
Na_2HPO_4	5	3·5	9·9	4·9	12·0
Na_2HPO_4	10	4·7	12·2	4·9	12·0
Na_2HPO_4	20	4·5	11·3	3·9	10·9

TABLE 4

Analysis of Variance of Grain Yields in 48-hour series in Pot Experiment 1

	Degrees of Freedom	*Sum of Squares*	*Mean Square*	*Variance Ratio*	*5 per cent. Point*	*One per cent. Point*
Treatments	6	3·220	0·5367	12·75	3·87	7·19
Error	7	0·295	0·0421			
Total	13	3·515				

Percentage standard error : ± 4·94.

	Soaking Solution — *Tap Water*	K_2HPO_4 5%	K_2HPO_4 10%	K_2HPO_4 20%	Na_2HPO_4 5%	Na_2HPO_4 10%	Na_2HPO_4 20%	*General Mean*	*Standard Error*	*Significant Difference*
Mean Yield per 10 plant pot in gm.	3·45	4·15	4·1	4·7	3·5	4·7	4·45	4·15	±0·145	0·485
Per cent.	100	120·3	118·8	136·2	101·4	136·2	129·0	—	±4·20	14·0

The magnitude of the increases in the 48-hour series are considerable, amounting to as much as 36·2 per cent. in the instance of 20 per cent. dipotassium hydrogen phosphate and 10 per cent. disodium hydrogen phosphate. It may be concluded that the effect of phosphate solutions on the seed has been definite and considerable.

In the 72-hour series, plants derived from phosphate-soaked seed showed no increase in yield of grain over the control. It appears that the 72 hours soaking has been too severe and has damaged the seed.

Effect on Straw Yields.—Though there has been a consistent increase in straw within the 48-hour series, the error variance was high and statistical significance was not reached. The means of all phosphate treatments exceeded the mean of the control. There are indications that the sodium salt is more injurious to the seed at high concentrations than the potassium salt. Increase of the concentration of the sodium salt from 10 per cent. to 20 per cent. is accompanied by a reduction in the yield of both grain and straw; there is no parallel reduction in the instance of the potassium salt.

Experiment II

This trial, which was largely a repetition of the first one, was set down in *yala*, 1948. The same soil was used with an application of compost of 2·5 per cent. and half the pots received a dressing of potash of 0.0025 per cent. K_2O as muriate. This potash treatment was given because the soil was known to be deficient in potash and there were indications in the first experiment of a response to potash. Tests were confined to one salt, viz., dipotassium hydrogen phosphate, and to one soaking duration, viz., 48 hours. Seed of the pure line, *Pachchaiperumal 2462/11* was sown on July 3, and reaped on October 20, 1948; the life period was 109 days. The large amount of shattering that occurred contributed to the high error in the variance analysis of grain yields.

Effect on Germination.—Soaking in phosphate solutions depressed the rate of germination in a manner similar to the first experiment. The final germination percentages decreased with increase in concentration of solutions, except for the anomalous behaviour in the instance 20 per cent. phosphate on potash-treated soil. The seeds were germinated in the pots and it appears that germination was adversely affected by the potash dressing in the second series. The potash soil dressing caused a significant increase in the height of the plants, whereas heights had not been noticeably affected by any of the treatments in the first experiment.

Effect on Grain Yields.—Complete grain and straw yields are given in Table 5. The potash dressing on the soil produced a highly significant increase in grain. The phosphate soaking showed no significant effects. Individual pot yields were erratic, and the error was high. Nevertheless, apart from the depression in the instance of the 20 per cent. phosphate on potash-dressed soil, all phosphate-soaking treatments exhibited yield increases.

Effect on Straw Yields.—Table 6 presents the variance analysis of straw yields. Both phosphate and potash produced large effects on the straw yields. Potash added to the soil increased the straw significantly, and there is an indication of a positive interaction between potash and phosphate.

The phosphate soaking as a whole significantly increased the yields of straw. Except for the anomalous figures for 20 per cent. phosphate on potash-dressed soil, the straw yields rose with increasing concentration of phosphate.

TABLE 5

Yields of Grain and Straw in Experiment II

		Muriate of Potash							
		None				*0·0025%*			
		Control	*Seed soaked in K_2HPO_4*			*Control*	*Seed soaked in K_2HPO_4*		
			5%	*10%*	*20%*		*5%*	*10%*	*20%*
Grain	Mean per 10-plant pot in gm. ..	7·1	7·7	7·7	8·1	11·6	12·2	13·1	10·7
	Per cent. ..	100	108·5	108·5	114·1	163·4	171·8	184·5	150·7
Straw	Mean per 10-plant pot in gm. ..	22·9	24·0	23·9	25·8	29·4	35·9	41·7	34·0
	Per cent. ..	100	104·8	104·4	112·7	128·4	156·8	182·1	148·5

TABLE 6

Analysis of Variance of Straw yield in Experiment II

	Degrees of Freedom	*Sum of Squares*	*Mean Square*	*Variance Ratio*	*5 per cent. point*	*1 per cent. point*	*0·1 per cent. point*
Treatments ..	3	885·96	295·32				
Phosphate ..	1	100·59	100·59	6·06*			
Potash ..	1	742·59	742·59	44·71†	4·35	8·10	14·82
Interaction ..	1	42·78	42·78	2·58			
Error ..	20	332·19	16·61				
Total..	23	1,218·15					

Percentage standard error : ± 13·8.

* Significant at 5 per cent. point.
† Significant at 0·1 per cent. point.

ABSORPTION OF PHOSPHATE BY PADDY SEED

The results of determinations of the intake of phosphate by seed of the variety used in the preceding experiments from 5, 10 and 20 per cent. solutions of dipotassium hydrogen phosphate, are presented in Table 7. Controls with tap water as the soaking solution are included. Parallel determinations were made on seed washed in 10 changes of distilled water, and on unwashed seed. The loss on washing was expected to provide an estimate of the quantity seated on the outer surface of the husk (lemma & palea). After air drying, the husk was separated from the rice, and determinations of the P_2O_5 content of the two components were made.

Table 7 indicates that quantities of P_2O_5 ranging from 0·15 gm to 0·27 gm. were absorbed by 100 gm. of seed. Slightly over half the quantity of P_2O_5 taken up is removed by washing, and may be assumed to be deposited on the outer surface of the husk. The greater part of the remaining fraction is seated inside the tissues of the husk and very little, if any, of the P_2O taken up appears to have entered the kernal.

TABLE 7

The content in P_2O_5 of components of Soaked Seed

Distribution of P_2O_5 in 100 gm. Quanties of oven-dried Seed

Soaking Solution	Unwashed			Washed		
	Husk	Rice	Total	Husk	Rice	Total
Tap water	0·04 gm.	0·68 gm.	0·72 gm.	0·04 gm.	0·68 gm.	0·72gm
5% K_2HPO_4	0·19 ,,	0·76 ,,	0·95 ,,	0·10 ,,	0·72 ,,	0·82 ,,
10% K_2HPO_4	0·17 ,,	0·70 ,,	0·87 ,,	0·14 ,,	0·68 ,,	0·82 ,,
20% K_2HPO_4	0·19 ,,	0·80 ,,	0·99 ,,	0·18 ,,	0·68 ,,	0·86 ,,

SUMMARY

In pot experiments set down at Peradeniya, with the paddy pure line *Pachchaiperumal 2462/11*, significant and striking increases in the yield of both grain and straw were obtained by soaking seeds in phosphate solutions. Forty-eight hours' soaking in 5, 10 and 20 per cent. K_2HPO_4 produced significant increases in the yield of grain of 20·3, 18·8 and 36·2 per cent over the control. Forty-eight hours' soaking in 10 and 20 per cent. Na_2HPO gave significant increases in the yield of grain of 36·2 and 29·0 per cent over the control.

Soaking in phosphate solutions delayed germination, the delay increasing *pari passu* with concentration of solution and duration of soaking.

Determinations of the quantities of phosphate that had entered the soaked grain were made.

PART II—FIELD EXPERIMENTS

Experiment I

The seed soaking treatments that had shown promise in pot experiments were tested on a field scale at the Experiment Station, Maha-Illupalama, in the *Maha* season, 1948–49. In this experiment, three concentrations of dipotassium hydrogen phosphate, viz., 0, 5 and 10 per cent., and two durations of soaking, viz., 24 and 48 hours, were tested with two 3-months pure lines viz., *Pachchaiperumal 2462/11* and *Dahanala 37 YM 2014*. The design was factorial.

Material and Methods.—The twelve treatments were distributed over three randomized blocks each of twelve 1/170-acre plots. The land was ploughed, harrowed and levelled in the usual way, but received no manure. The plots were broadcast with sprouted seed on January 3, 1949. Each plot was sown with ½ lb. (227 gm.) of seed which had been soaked in 227 ml. of the appropriate solution.

Results.—Three-weeks-old plants derived from phosphate-soaked seed developed a more marked green colour than the controls. This colour difference persisted up to the sixth week.

Flowering records showed no effect of the soaking treatments on age. The analysis of variance of the yields of grain given in Table 8 indicated the superiority of *Pachchaiperumal 2462/11* over *Dahanala 37 YM 2014*. The percentage standard error of the experiment was 9·6. The results are presented below in the two two-way Tables 9 and 10.

TABLE 8

Analysis of Variance of Grain Yields in Field Experiment I

	Degrees of Freedom	*Sum of Squares*	*Mean Square*	*Variance Ratio*	*Five per cent. Point*	*One per cent Point*
Treatments ..	11	30·759	2·796			
Pure lines ..	1	22·189	22·189	20·5	4·30	7·94
Phosphate concentrations	2	5·082	2·541	2·3	3·44	5·72
Soaking durations ..	1	0·002	0·002			
Interactions—						
Pure lines × concentrations ..	2	0·817	0·408			
Pure lines × durations	1	0·406	0·406			
Concentrations × durations ..	2	2·102	1·051			
Pure lines × concentrations × durations ..	2	0·161	0·080			
Blocks	2	0·666	0·333			
Error	22	23·785	1·081			
Total ..	35	55·210				

TABLE 9

Yields of Grain in Field Experiment I

Variety / *Soaking Solution*	*Pachchaiperumal 2462/11*	*Dahanala 37 YM 2014*	*Mean*
Distilled water ..	2,065 lb./acre .. 90·6 per cent.	2,494 lb./acre .. 109·4 per cent.	2,279 lb./acre .. 100·0 per cent.
per cent. K_2HPO_4 ..	1,972 lb./ acre .. 86·5 per cent.	2,227 lb./acre .. 97·7 per cent.	2100 lb./acre .. 92·1 per cent.
0 per cent. K_2HPO_4 .. 92·0 per cent.	2,098 lb./ acre .. 92·0 per cent.	2,453 lb./acre .. 107·6 per cent.	2,276 lb./acre .. 99·9 per cent.
Mean ..	2,045 lb./acre .. 89·7 per cent.	2,391 lb. /acre .. 104·9 per cent.	..

TABLE 10

Yields of Grain in Field Experiment I

Soaking Duration *Soaking Solution*	*24 hours*	*48 hours*	*Mean*
Distilled water	2,227 lb./acre 97·7 per cent.	2,231 lb./acre 102·3 per cent.	2,229 lb./acre 100·0 per cent
5 per cent. K_2HPO_4	2,083 lb./acre 91·4 per cent.	2,116 lb./ acre 92·8 per cent.	2,100 lb./ acre 92·1 per cent.
10 per cent. K_2HPO_4	2,350 lb./acre 103·1 per cent.	2,202 lb./acre 96·6 per cent.	2,276 lb./acre 99·9 per cent.
Mean	2,220 lb. /acre 97·4 per cent.	2,183 lb./acre 97·2 per cent.	

Experiment II

This experiment tested the effect of soaking seed of the 4-months selections, *Vellai-ilankalayan 28061* and *Honderawala 868*, for 48 hours in a 10 per cent. solution of disodium hydrogen phosphate. Controls which had been soaked in distilled water for the same period were maintained.

Material and Methods.—In the instance of each of the four treatments, 3 lb. (1361 gm.) of seed were soaked in 1361 ml. for 48 hours, and the sprouted seed was sown in 300 sq. ft. of nursery on December 8, 1948. The seedlings were transplanted at the rate of three per hill, in hills spaced six inches apart, to six randomized blocks each of four 1/150-acre plots. Neither the nursery nor the field plots received any manure.

Results.—Striking superiority in vigour and height of plants derived from phosphate-soaked seed was noted 10 days after transplanting. These plants were, moreover, darker green. Height measurements of random samples of 25 plants in three of the blocks, made on February 21, 1949, are given below in Table 11. By this date, the benefit of the phosphate soaking was evident only in *Honderawala 868*.

TABLE 11

Mean Plant Height in Field Experiment II

Pure Line *Soaking Solution*	*Vellai-ilankalayan 28061*	*Honderawala 868*	*Mean*
Distilled water	105·0 cm. 103·5 per cent.	97·9 cm. 96·5 per cent.	101·5 cm. 100·0 per cent.
10 per cent. Na_2HPO_4	104·5 cm. 103·0 per cent.	104·8 cm. 103·3 per cent.	104·7 cm. 103·1 per cent.
Mean	104·8 cm. 103·2 per cent.	101·4 cm. 99·9 per cent.	

Flowering records revealed no effect of soaking treatments. The analysis of variance of grain yields given in Table 12 demonstrated the significant and striking superiority of *Vellai-ilankalayan 28061* over *Honderawala*

868. The phosphate soaking showed no significant benefit. The experiment had a standard error of 7·8 per cent. The yields of grain are presented below in the two-way Table 13.

TABLE 12

Analysis of Variance of Grain Yields in Field Experiment II

	Degrees of Freedom	*Sum of Squares*	*Mean Square*	*Variance Ratio*	*Five per cent Point*	*One per cent. Point*
Varieties ..	1	130·378	130·378	124·86	4·54	8·68
Soaking treatments ..	1	2·098	2·098	2·00	4·54	8·68
Interaction ..	1	2·080	2·080	1·99	4·54	8·68
Blocks	5	61·867	12·373			
Error	15	15·675	1·045			
Total ..	23	256·098				

TABLE 13

Yields of Grain in Field Experiment II

Variety / *Soaking Solution*	*Vellai-ilankalayan 2061*	*Honderawala 868*	*Mean*
Distilled water	.. 3,562 lb./acre 112·9 per cent.	.. 2,748 lb./acre .. 87·1 per cent.	.. 3,155 lb./acre. .. 100·0 per cent.
10 per cent. $Na_2 HPO_4$	.. 3,562 lb./acre 112·9 per cent.	.. 2,445 lb./acre .. 77·5 per cent.	.. 3,004 lb./acre .. 95·2 per cent.
Mean	.. 3,562 lb./acre 112·9 per cent.	.. 2,597 lb./acre .. 82·3 per cent.	

DISCUSSION

In the field, there were in plants derived from phosphate-soaked seed, early but evanescent indications of superiority in vegetative vigour. The failure to reproduce the yield increases obtained in preliminary pot experments may find an explanation in the lower degree of precision of the field trials, or in limiting soil factors. It is not possible to pronounce on the value of the pretreatment technique without extensive and exact experiments with various placement methods and with a wide range of soil types.

The height measurements in the second experiment suggest a variety-treatment interaction within the same age class. Information is desired on the effect of age on response to phosphate-soaking. On the assumption that effects on yield are likely to be more marked when the sowing-harvest interval is short, preliminary trials have been confined to 3 and 4-months paddies. If however, the accumulation of early phosphate-soaking benefits follows Blackman's compound interest law, the longer-aged varieties are likely to show more striking yield responses.

ACKNOWLEDGMENTS

We are indebted to Dr. D. E. V. Ayyar, Chemist, for valuable assistance, and to Mr. D. G. Panditrao, of the Chemical Division, for the determinations of the P_2O_5 content of paddy seed.

REFERENCES

1. Narayanan, T. R., and Sripada Krishnan, S. (1945) "A Note on Pre-soaking in Phosphate Solutions for increasing Seed to Fruit Ratio" *Madras Agr. J.*, xxxiii, 176-177.

2. Ramiah, M. (1945) "Conservation of Mineral Nutrients by soaking seed in nutrient solutions" *J. Ind. Soc. Soil Sci.* xxxviii, 45.

On the Value of Some Legumes

BY

W. R. C. PAUL

PERADENIYA

FROM earliest times leguminous plants have played an important role in agriculture. They have long been recognised as of value in providing the three essential requirements of food, forage and fertility maintenance. Two of the oldest crops in the world are lucerne, a forage legume which was first grown in South-Western Asia and soya beans, a pulse of great antiquity in China. In the West, the establishment of a rotation with the introduction of a leguminous crop at regular intervals laid the foundation for intensive agriculture and in the tropics legumes formed a useful component of mixed cropping. During the present century legumes have been introduced to aid soil conservation and to provide protection against insolation and wind for permanent crops like tea and cacao though the practice in coffee is quite old (11). Individual species are also grown for particular purposes, e.g., sunnhemp for fibre and groundnuts for oil.

In the monsoon tropics, high temperatures and heavy rains bring about considerable losses of soil nitrogen through denitrification and leaching when the vegetational cover—the forest climax—is removed, and permanent or annual crops are grown in succession. On undulating and high lands where drainage is unimpeded, further losses take place as a result of the lateral movement of water and soil when no restriction is offered.

Nitrogen can, however, be regained through the agency of leguminous plants. Following on the discovery in 1886 that nitrogen from the air within the soil can be fixed by the symbiotic bacteria (*Rhizobium* species) which exist in the nodules on the roots of most legumes, methods are being investigated by which greater use can be made of this important family of plants in different agricultural systems. There is a greater preponderance of legumes in the tropics and there are many species of forage and green manure value whose suitability for cultivation under various methods in different tropical countries has not been fully explored.

All leguminous species do not form nodules and therefore do not produce nitrogen. Two commonly occurring species on waste land, chiefly in the dry zone areas of Ceylon are *Cassia occidentalis* Linn. (Singh. *peni tora* Tam. *ponnantakarai*) and *C. tora* Linn. (Singh. *peti tora*. Tam. *vadda* or *pandi takarai*) and in these nodules are not formed. On the other hand, *C. absus* Linn. (Singh. *bin tora*) a species of similar habitat but of much less frequency and *C. leschenaultiana* D. C. a weed which occurs on waste places in the wet zone nodulates freely. Species also vary in the efficiency of nodulation.

The quantity of nitrogen added to the soil in the case of the large majority of nodule forming legumes is quite considerable and may vary between 100 and 150 lb. of nitrogen and even more, depending on the degree of nodulation, the quantity of foliage and the density of the stand. Half the nitrogen in the plant is assumed to come from the soil and the other half from the air though the relative amounts taken up from the soil and the air vary with the legumes. The percentage of nitrogen in the roots is 1·4 to 2·3 and in the leaves 2·10 to 4·84 based on the dry matter at 100° C. The leaves contain about 4 to 5 times the quantity in the stem. As pointed out by Mckee (12) since about one third of the total nitrogen of most legumes is in the roots over half the nitrogen added to the soil would be taken from the air in the case of those crops which are used for forage and for seed, where part of the tops would be returned to the soil. Legumes which are to be grown for forage and as green manures should be leafy and should be utilised before the stems become woody.

There are two morphological types of leguminous plants which are grown for the improvement of soil fertility as well as for checking soil erosion. These are the trailing or ground covers and the erect or bush covers. Forage legumes as well as those grown as beans or pulses in mixture with arable crops may also be trailing or erect types.

Trailing Covers.—This type of cover is mostly herbaceous and it protects the soil from the impact of heavy rain and insolation by the close growth produced along the surface of the soil. Weeds are smothered and leaching prevented. Humus is added to the soil by the decomposition of the roots, leaves and stems, microbial activity is encouraged and crumb structure improved. These covers are useful on sloping land under permanent crops especially during the early period in the establishment of the latter. Their value lies in their ability to form a complete cover quickly and to remain on the land without dying out either in patches or altogether. Resistance to pests and diseases is desirable, particularly to eelworm disease caused by the root knot nematode (*Heterodera marioni*) (Cornu) Goodey and to attacks of aphides, bugs and the flee beetle (*Longitarsus* sp.) on the leaves.

The popular perennial species are *Calopogonium mucunoides* Desv. and *Pueraria phaseoloides* (Roxb.) Benth. (tropical kudzu) for coconut plantations and *Desmodium ovalifolium* Wall for rubber. *Indigofera endecaphylla* Jacq. was regarded some years ago (2, 3, 5) as a promising cover for tea but it did not subsequently fulfil this expectation partly because the shoots tend to grow through the tea bushes and the cover itself could not survive under the low shade obtained under well-established tea. So far no satisfactory leguminous ground cover has been found for tea nor indeed is it necessary with a close stand of bushes. In the observation plots at the Experiment Station, Peradeniya, a strain of *Pueraria phaseoloides* received some years ago from South India is markedly superior to one received from the Philippines and to the local variety as well as to *Calopogonium mucunoides* in vigour of growth, size of leaves and quantity of green material produced. Under the conditions of greater shade provided by rubber, *Desmodium ovalifolium* is a more satisfactory crop.

In arable cropping, certain annual trailing varieties of cowpea (*Vigna sinensis* Linn.) which grow rapidly and produce a dense leafy growth are

PHOTO 1.—Plants of *Crotalaria brownei* Bertol.

FIG. 1.—*Crotalaria brownei* Bertol showing leaves, flowers and pods.

of value as a green manure and forage crop to be grown in rotation with other crops. The leaves and vines make good roughage but unfortunately this legume is susceptible in certain seasons to attacks of the bean fly (*Agromyza phaseoli* Coq.), to aphides and to wilt disease caused by *Sclerotium rolfsii* Sacc. A variety which is reported to produce much green material received from the Council of Scientific and Industrial Research, Australia, is under trial at the Experiment Station, Peradeniya. Other legumes used in this way in the tropics and also as a cover crop in orchards are *Mucuna aterrima* Holland (*Stizolobium aterrimum* Piper and Tracy) or the Bengal bean, *M. deeringiana* (Bort.) Holland (*S. deeringianum* Bort.) or the Florida velvet bean and *Canavallia ensiformis* D. C., the trailing variety of the sword bean, there is the likelihood from preliminary trials that the first species will be superior to cowpeas in vigour of growth and resistance to pests and diseases.

Erect Covers.—The erect types are woody or semi-woody when a few months old and are mainly grown in contour strips in young plantations of permanent crops. They are used as green manures by periodically lopping the tops and turning these into the soil between the rows of the crops. They provide temporary shade for newly planted permanent crops and afford protection against the lateral movement of soil by serving as a barrier which acts as a sort of filter for the excess water. The species included in this category reach a height of 4-10 feet and generally become woody or semi-woody after about 4 months' growth. When the base of the stems tend to be woody or the plants die back after several loppings they should be uprooted. Sunnhemp (*Crotalaria juncea* Linn.) is a popular green manure in rotational cropping and is the least woody of the Crotalarias. It is short-lived, sheds its leaves and dies down after the formation of its pods. It is quick growing, but being a small plant a close stand is necessary and consequently a high seed rate—40 lb. per acre for seed production and 60 lb. per acre for green material (7). This legume is badly attacked by the bug (*Ragmus importunitas* Dist.) which causes scarring and discolouration of the leaves to such an extent as to reduce considerably the yield of green material and seed production under conditions at Peradeniya.

There are several other species of *Crotalaria* which produce a large quantity of leafy material but are not as quick growing in the early stages. The two popular species for plantation crops are *Crotalaria usaramoensis* Baker and *C. anagyroides* H.B.K. In observation plots at the Experiment Station, Peradeniya, these two species were grown along with a number of other species of *Crotalaria*, *Tephrosia* and *Desmodium*. Amongst the Crotalarias under study, the species which gave the heaviest foliage and showed marked resistance to attack of the leaves by the bug *Ragmus importunitas* Dist. and the flea beetle (*Longitarsus* sp.) was *C. Brownei* Bertol. The other species which are listed in order of decreasing susceptibility to *Ragmus* are *C. juncea* Linn., *C. grahamiana*, W. and A., *C. anagyroides* H. B. K., *C. usaramoensis* Baker, and *C. striata* D. C. (=*C. mucronata* Desv. of American authors).

C. Brownei is an indigenous species which has a good branching habit and grows to a height of 6-8 ft. before flowering especially on soils which have been treated with phosphates (Photo 1). It has large trifoliate leaves, dark bluish green in colour, the terminal leaflets being slightly larger than the other two (Fig. 1). The leaflets are oblong-acute in shape, 8-11 cm. long and 4-7 cm. broad, with a mucronate tip. The flowers are yellow without

any striations on the standard petal, and are borne on moderately dense racemes. The pods are slender, light brown and glabrous. Flowering commences in 4 months' time and seed can be collected about a month later. Nodulation is efficient. The plants can be lopped several times. The Crotalarias are with the exception of *C. juncea* Linn. known to be resistant to eelworm attack and are able to grow according to Mckee (12) on poor acid soils.

Two other bush legumes which produce a large quantity of leafy material are *Desmodium gyroides* D. C. and *Tephrosis vogelii* Hook.

D. gyroides is an indigenous plant which can grow to a height of 9 ft. before flowering on good soils (Photo 2). It has large trifoliate leaves, the terminal leaflets being much larger than the other two (Figs. 2 and 3). The leaflets are ovate-elliptic, obtuse, the terminal leaflets measuring 5·5-7·5 cm. long and 3·8-4·5 cm. broad. In the young plant the leaves, are simple. A characteristic red blotch appears on the stipules. In the early stages, growth is slow. Flowering commences in about 5½ months' time, the flowers being pale blue in colour. A heavy foliage is produced which is quite free from any pest attack. It has so far not been found to be susceptible to eelworm disease. A long tap root is produced even in the young plants. Nodulation is not vigorous through it takes place quite early. Some stems tend to grow outwards from the base in the young plants and these develop adventitious roots at the nodes where they touch the soil. The plant can be propagated both from seed and cuttings. It is palatable to stock.

T. vogelii was introduced in 1921 and is found to be the most satisfactory species amongst the Tephrosias examined. Its leaves are imparipinnately compound, the leaflets being narrowly oblong-elliptic, obtuse, 5·5-8·5 cm. long and 1·5-2·5 cm. broad (Fig. 4 and Photo 3). They are thick but soft in texture and soon decay on falling to the ground. The stems and leaves are covered with brown hairs. The plants grow more rapidly than *D. gyroides* and on good soils reach a height of 10 ft. before flowering. Large white flowers (Photo 4) are produced in about 5 months' time. This species provides a much larger quantity of green material than any of the other Tephrosias under observation, viz., *T. candida* D. C., *T. noctiflora* Boj. ex. Baker, *T. toxicaria* Pers., *T. villosa* Pers. and *T. purpurea* Pers. The pods of *T. vogelii* are much larger than those of *T. candida* and unlike the latter are free from insect attack. The roots are, however, susceptible to eelworm disease.

These three bush legumes, *Crotalaria Brownei*, *Desmodium gyroides* and *Tephrosia vogelii* are recommended for planting in contour hedges in the wet zone up to an elevation of about 2,000 ft. in tea, coconuts and young rubber and on arable land and home gardens.

Forage and Pasture Legumes.—The stems and leaves of legumes have a much higher protein content than grasses. They are also rich in calcium and are fairly well supplied with phosphorus and the vitamins A and D. Species which are palatable to stock and have no toxic effect are used either on the soiling system whereby they are cut as green fodder and fed direct or after turning into hay or silage to livestock or are grown mixed with grasses in pastures which are subject to intermittent grazing. Lucerne is the most valuable forage crop in western countries and in Australia. It is capable

PHOTO 2.—Plants of desmodium gyroides D. C.

FIG. 2.—*Desmodium gyroides* D. C. showing leaves and terminal inflorescence.

FIG. 3.—*Desmodium gyroides* D. C. shewing development of pods.

FIG. 4.—*Tephrosia vogelii* Hook showing leaflets, flowers and pods.

PHOTO 3.—Plants of *Tephrosia vogelii* Hook.

PHOTO. 4.—*Tephrosia vogelii* Hook with terminal inflorescence

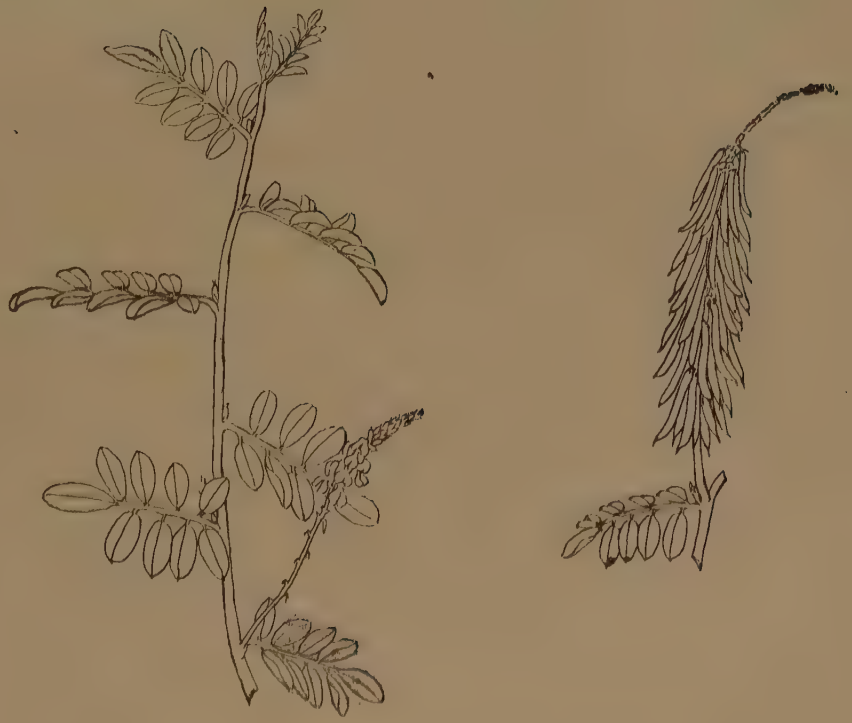


Fig. 5.—*Indigofera endecaphylla* Jacq. showing leaves, inflorescence and pods.

of rapid growth and gives several cuts of highly nutritious fodder a year. It makes a good hay crop and is also used as silage as well as, more recently, in pastures. But it is a heavy feeder and requires liberal applications of lime, phosphate and potash. Lucerne has been successfully grown in observation plots at the Experiment Station, Peradeniya, and has produced seed. Trials are in progress to compare the total quantity of green fodder as well as of hay that can be produced a year in comparison with other legumes which grow well at this Station and are palatable to stock such as *Stylosanthes gracilis* H. B. K., *Desmodium ovalifolium* Wall and *D. gyroides* D. C. Stylo is a legume which grows remarkably well even on poor laterite soils and a considerable improvement in the structure of the soils can be observed after this legume has occupied the land for a number of years. It is a useful pasture legume (9) but it can also be cut and fed as green fodder. *Lespedeza* has been tried and though it seeds and germinates satisfactorily it does not grow much above a height of 4 in. and therefore is of little use.

When the tall fodder grasses such as Guinea (*Panicum maximum* Jacq.) and Napier (*Pennisetum purpureum* Schum.) are grown for soiling purposes the nutritive value of the forage can be greatly improved by interplanting perennial legumes which are palatable to stock and can withstand periodic cutting. The soil as well as the grass will benefit by the association. The legumes previously recommended for pastures in the wet lowlands (9) are also suitable for planting between the rows of fodder grasses. Another legume *Indigofera endecaphylla* Jacq. (creeping indigo) (Fig. 5) has been found valuable both in mixture with fodder as well as pasture grasses. This legume was observed growing in swards along the banks and edges of the arable fields and roadside verges at the Experiment Station, Peradeniya, in mixture with the local grasses such as *Axonopus compressus* (Swartz) Beauv., *Digitaria sanguinalis* (L) Scop., *Cynodon dactylon* Pers., *Eleusine indica* Gaertn., and *Dactyloctenium aegyptium* (L) Richt. These strips have been frequently slashed as well as grazed and the *Indigofera* has persisted. It was, therefore, selected for planting in pasture blocks both in the open and under coconuts as well as in poultry runs in mixture with the grasses *Melinis minutiflora* Beauv. (Molasses grass) *Paspalum dilatatum* Poir, *Brachiaria distachya* Stapf. and *B. miliformis* Chase, the other legumes being *Alysicarpus vaginalis* D. C. (Sinh. *Aswenna*) and *Stylosanthes gracilis* H. B. K. These pastures were subject to rotational grazing and the runs on which these grasses and legumes were established were maintained on the intensive system with fixed night houses as well as movable fold units. *Indigofera* has proved palatable to cattle, poultry, and pigs and it combines well with grasses and other legumes. No toxic effects were observed but according to a communication dated November 8, 1949, from O. R. Younge, Associate Agronomist in Hawaii, some toxicity was observed there in preliminary feeding and pasture trials with this legume when used as the sole or major source of roughage. It is possible that the variety grown in Ceylon belongs to a non-toxic strain. It is a common legume in grasslands in East Africa and in observations carried out on the palatibility of some of the indigenous legumes there it was found to be wholly relished by cattle and sheep (1).

Indigofera endecaphylla produces long, slender, and slightly reddish stems which creep as well as climb on to other plants growing in proximity

to it. A deep tap root is developed and there are numerous adventitious roots at the nodes wherever the stems come in contact with the soil. The leaves are imparipinnately compound, the leaflets being 1-2·5 cm. long and ·75-1·0 cm. wide numbering 7-9, arranged alternately. The flowers are small, purplish pink and are borne on a long stalk and the pods which are slender, cylindrical, and brown in colour are produced in clusters, each containing 6-9 seeds. The plant can be propagated both from seed as well as cuttings. Nodule formation is good. In an observation plot in which this was the sole species growing for a number of years, eelworm disease was detected but so far no attack has been observed in the plots growing in mixtures with grasses and other legumes. In view of the recent discovery by Timson in Southern Rhodesia and others that where the organic matter content of the soil is high, the nematode does not thrive because of the presence of predatory organisms and that dressings of green material, cattle manure or compost can effectively reduce the population of *Heterodera* it is unlikely that on pastures subject to grazing this disease will occur.

Intercalary Cultivation.—Certain legumes can be grown with advantage between the rows of a main annual crop. There are numerous instances of mixed cropping with legumes and non-legumes in peasant agriculture of tropical countries. The subject has been discussed by several writers (6, 11). In fact, with the exception of paddy, continuous monoculture does not obtain in peasant agriculture. The important claim now sponsored for mixed cropping with legumes is the availability of readily assimilable nitrogen provided by the legume to the non-legume growing in close association with each other. Nicol (6) has in addition pointed out the value of the biological contribution made by the legume to the soil. Amongst food crops, well-known mixtures are cereals and pulses. In the case of the intercalary cultivation of kurakkan (*Eleusine coracana* Gaerth) and green gram, a better total yield was obtained from the mixture than from the sum of the separate crops grown on the same unit of land (8).

Apart from these important considerations, intercalary cropping will result in a better cover of the soil, especially in the early stages of growth of the main crop. Protection is thus afforded to the soil against erosion, insolation and leaching and also microbial activity is encouraged. With the quick growing species weed growth can be kept down. It is desirable that the legume should germinate quickly and grow rapidly so as to form a cover which will effectively keep down weeds. If the legume is to be planted primarily for the protection of the soil then it should be sown broadcast between the rows but if the production of beans is the main consideration then it is best drilled in rows at a suitable spacing depending on the distance between the rows of the main crop. In the case of erect legumes if the plants grow too tall and tend to interfere with the growth of the main crop then they can be cut down to ground level and the loppings used as a mulch between the rows. In this way continued protection can be given to the soil and weeds suppressed. In addition, a mulch of green material will be effective in dry weather in retaining moisture below it. The more resistant the material to decay, the more valuable it becomes from this point of view. It was found that a mulch of bamboo leaves spread between the rows of crops like chillies and brinjals considerably extended their growth periods and the production of

fruits. Legumes differ in the rate of decay of their leaves, e.g., *Desmodium gyroides* has leaves which are much more resistant to decay than *Tephrosia vogelii*.

The study of a number of legumes was taken up for their suitability for intercalary cultivation between the rows of such arable crops as cereals, chillies, brinjals, manioc, and the large-leaved yams (*Colocasia esculenta* (L) Schott and *Xanthosoma sagittifolium* (L) Schott. The legumes include bean and green manure trailing and erect crops. Those which are most promising are soya beans and the erect varieties of cowpeas amongst the bean crops, *Crotalaria Brownei* and *Tephrosia vogelli* amongst the erect green manure crops. It was found that the large seeded bean crops grow more rapidly in the early stages than the green manures. This is an important consideration in weed control, but the bean crops mature early and then die down while the late maturing green manures form a more effective cover in the later stages. It is possible that a mixture of the early maturing and late maturing legumes may give better results. There is much work to be done on this subject of intercalary cropping. The choice of suitable legumes, the method of sowing, the time of sowing, and the method of treatment are questions that have to be determined for each main crop. It should be stressed that the protection of the soil for as long a period as possible by legumes which will not interfere with the growth of the main crop but which will benefit it by contributing to the fertility of the soil should be the main objective in intercalary cropping. Fallow periods between two main crops in a rotation should be avoided or reduced to a minimum. When one main crop is over the intercalary legume can cover the ground or form with it a stubble mulch. In this way, the legumes function as protective crops. Preparatory tillage operations for the next season can be confined to disc harrowing the stubble, ploughing being omitted altogether. This system has been adopted at the Experiment Station, Peradeniya, and is held to be valuable in maintaining soil fertility.

SUMMARY

There are in the tropics numerous legumes whose value for forage and green manure purposes has still to be studied. The perennial trailing varieties are useful as ground covers for certain permanent crops. A strain of *Pueraria phaseoloides* (Roxb.) Benth. from India was found superior to one received from the Philippines and the local variety. Under the conditions of greater shade provided by rubber, *Desmodium ovalifolium* D. C. is more satisfactory. No suitable legume as a ground cover has been found nor is considered necessary in well-established tea. In arable cropping, annual trailing crops are of value to be grown in rotation with other crops. So far, the cowpea is the most satisfactory although it is susceptible in certain seasons to attacks of the bean fly (*Agromyza phaseoli* Coq.), to aphides and wilt caused by *Sclerotium rolfsii*.

Amongst the erect legumes, Sunnhemp (*Crotalaria juncea* Linn.) is the most satisfactory in rotational cropping but at Peradeniya it is badly attacked by the bug (*Ragmus importunitas* Dist.). For planting in contour strips the later maturing but more woody species which have been found most suitable are *Crotalaria Brownei* Bertol., *Tephrosia vogelii* Hook, and

Desmodium gyroides D. C. The first two are efficient in nodulation and are quick growing but the last produces a large quantity of leafy material which is more resistant to decay.

As regards forage legumes. *Indigofera endecaphylla* Jacq. has given evidence of being the most satisfactory. It can be grown in pastures as well as interplanted with fodder grasses. It is palatable to cattle, poultry and pigs and no toxic effects were observed.

The intercalary cultivation of a legume between the rows of a main annual crop is desirable in the tropics. Apart from the contribution of nitrogen by the legume to the associated crop, protection is afforded to the soil against erosion, insolation and leaching. Microbial activity is encouraged and with quick growing legumes which produce a dense growth weeds can be suppressed in the early stages. In the case of erect legumes, if the plants grow too tall and tend to interfere with the growth of the latter they can be cut down and the loppings used as a mulch between the rows. There is much work to be done in this subject. For the present it can be stated that amongst the early maturing legumes soya beans and cowpeas are suitable and for the late maturing species *Crotalaria Brownei* and *Tephrosia vogelii* are the most promising.

LITERATURE

1. Bogtian, A. V.—Observations on palatability of some leguminous plants of Kenya. The East African Journal, Vol. 15, No. 1, 1949.
2. Holland, T. H.—A trial of *Indigofera endecaphylla* in tea at Peradeniya. The Tropical Agriculturist, Vol. 79. No. 9, 1932.
3. Holland, T. H.—Experience in the use of creeping crops in tea cultivation with special reference to *Indigofera endecaphylla*. The Tropical Agriculturist, Vol. 70, No. 5, 1928.
4. Hosaka, E. G. and Ripperton J. C.—Legumes of the Hawaiian ranges. Hawaii Agric. Experiment Stn. Bulletin No. 93, 1944.
5. Joachim, A. W. R.—*Indigofera endecaphylla* as a conserver of the fertility of tea soils at Peradeniya The Tropical Agriculturist, Vol. 79. No. 9. 1932.
6. Nicol, H.—Mixed cropping in primitive agriculture. Empire Journal of Experimental Agriculture, Vol. 3, No. 10, 1935.
7. Paul, W. R. C.—A comparison of different seed rates of sunnhemp on the yield of green material and seed. The Tropical Agriculturist, Vol. 91, No. 12. 1938.
8. Paul, W. R. C. and Joachim, A. W. R.—Experiments on associated growth of leguminous and non-leguminous crops. The Tropical Agriculturist, Vol. 97, No. 5. 1941.
9. Paul, W. R. C.—Progress in pasture work in the humid lowland region. The Tropical Agriculturist, Vol. 104, No. 3, 1948.
10. A manual of green manuring. Department of Agriculture, Ceylon. 1931.
11. Leguminous plants in the tropics. International Institute of Agriculture, Rome. 1936.
12. Grasses. U. S. Department of Agriculture. Yearbook. 1949.

Progress of Cotton Cultivation in the South-Eastern Division with special reference to The Village Cotton Purchase Scheme

BY

H. A. PIERIS, B.A. (Cantab), A.I.C.T.A. (Trinidad)

DIVISIONAL AGRICULTURAL OFFICER, S. E. D.

Cotton Purchase Scheme 1948

COTTON cultivation in this newly established division, comprising Buttala and Wellawaya districts of Uva Province and the Hambantota District of Southern Province was resuscitated during the Maha Season, 1947, after a break of five years during the war period. During this period no cotton was grown except in the Tanamalwila area of Wellawaya District. In these years cotton had to make way to the more important food crops in view of the acute shortage of food. Chena permits for cotton cultivation were discontinued. Cotton cultivators fell into line with the rest in raising food crops under an organised drive initiated by Agricultural and Revenue Officers. The first opportunity was taken, however, after the termination of hostilities to launch out a cotton drive, after the tension of food production had somewhat abated. A planned programme was arranged for distribution of pure BP79 seed raised at the Cotton Rotation Station, Wirawila.

Since it was realised that the success of a venture of this nature depended largely on making seed available to all cultivators, especially in view of the fact that most of the cotton chenas were situated in distant jungle tracts, where transport facilities were difficult, arrangements were made to distribute the seed at convenient centres in different parts of the cotton growing belt. Every precaution was taken to ensure the proper and equitable distribution of seed to bona fide cultivators. Thereafter, cultivators were advised in regard to the more important cultural operations, weeding of plots, clean picking and grading. Cultivators were given an assurance regarding the purchase of their crops at the best possible market price offered by the Spinning and Weaving Mills in Colombo. Subsequent events have proved that the assurance of a guaranteed price and a ready market for the crop has in no small way contributed to the rapid expansion of this commodity as a village enterprise within a period of two years. The co-operation of the Divisional Revenue Officers was sought in collecting statistics regarding the cultivated extents, and crop forecasts, with a view to making arrangements for the "Purchase Scheme". Arrangements were made to procure the

necessary staff and material in preparation for the purchase, and when it was finally conducted every effort was made to handle the crop as expeditiously as possible so as to enable cultivators coming from distant places to get back to their homes before nightfall. Originally the purchase was arranged at three centres. Subsequently on representations made by the Divisional Revenue Officers that a few centres would necessitate cultivators to transport their crops over long distances, the number was increased to nine. The " Purchase " dates were also arranged to suit cultivators as they expressed a desire to dispose of their crops before the Sinhalese New Year in April. This meant a curtailment of the purchasing period and more organisation was necessary. However, this request was acceded to owing to the possibility of cultivators selling their crops to middlemen at reduced prices. Despite these precautions a few growers had disposed of their crops to traders but the latter were not admitted to the " Purchase " centres. Village Headmen were summoned to the " Purchase " centres for the purpose of identifying the bona fide cultivators with a view to eliminating the middlemen and traders.

The grading of cotton brought for sale on the whole was good particularly at Meegahajandura and Mattala centres. Cotton was clean and free from discolouration and stains. The bulk of the crop was first grade. Average yields obtained at the main centres were as follows :—

Angunupolapelessa and surrounding villages in East Giruwa Pattu	4 cwt. per acre
Meegahajandura, Mattala, and surrounding villages in Magam Pattu ..	6–8 cwt. per acre
Tanamalwila, Bodagama, and surrounding villages in Magam Pattu and Uva	5 cwt. per acre

The 1948 Purchase Scheme was a success. Cultivators were pleased with the price, namely, Rs. 32·50 for 1st grade cotton and Rs. 16/25 for second grade cotton offered by the Mills. It was evident therefore that a much greater extent would be brought under cultivation during the following season and a bigger organisation in respect of vehicles for transport of cotton, more staff, stores, &c., would be necessary for the next purchase scheme.

During the season under review 399 cultivators grew cotton in 375 acres approximately. A crop of 1,863¼ cwt. was purchased which realised a sum of Rs. 50,003·43.

Cotton Purchase Statement for the Season 1947–48

Date	*Centre*	*No. of Cultivators*	*Grade I* Cwt.	lb.	*Grade II* Cwt.	lb.	*Total* Cwt.	lb.	*Amount Paid* Rs.	c.
5.4.48	Angunukolapelessa	50	212	35	—		212	35	6.552	38
6.4.48	Barawakumbuke	23	119	11	2	22	121	35	3,595	65
7.4.48	Meegahajandura	107	480	21	—		480	21	13,445	25
8.4.48	Maththala	70	433	20	—		433	20	12,129	0
9.4.48	Kotakumbuka	89	393	37	16	99	410	24	8,686	20
10.4.48	Ambalantota	41	137	81	9	29	146	110	3.962	35
10.4.48	Gonnoruwa	8	41	93		102	42	83	1,181	45
27.4.48	Bata-ata	1	1	6	—		1	6	29	50
27.4.48	Kinchigune	6	8	87	1	67	10	32	263	65
2.5.48	Middeniya	4	5	80	—		5	80	160	0
		399					1,863	44	50,003	43

(Block by Survey Department.)

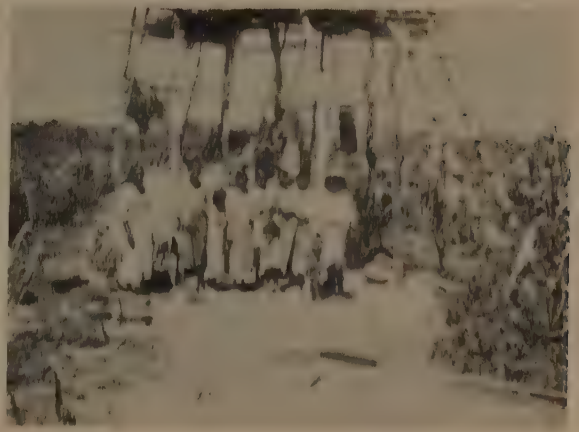
PLATE I. Cotton Plot (var.) BP 79
Experiment Station Hoanhantota

(Block by Survey Department.)

PLATE II. Pure Plot of Cotton with kurakkan in foreground
(Village Scheme)

(Block by Survey Department.)

PLATE III. Maintenance of Purity Plot BP 79
Experiment Station—Wirawila 1949



(Block by Survey Department.)

PLATE IV. A typical Chena carrying pure crops
of cotton, maize, kurakkan and chillie

(Photo by Survey Department.)

PLATE V. A plot of pure Cotton (BP 79) with Tuticorin Chilli in foreground grown by a cultivator in Tanamalwila District—Uva (Village Scheme)

Cotton Purchase Scheme 1949

For Maha Season, 1948, timely arrangements were made in regard to procuring a supply of pure BP79 seed raised at the Rotation Station, Wirawila. The crop was ginned at the Spinning and Weaving Mills, Colombo. Only on receipt of the pure seed was the cotton purchased under the village scheme despatched to the Mills. This precaution was taken with a view to eliminating the slightest possibility of contamination of our pure seed with seed of other varieties at the gins.

As in the previous season a planned programme of seed distribution was undertaken. In accordance with lists submitted by Divisional Revenue Officers seed was distributed at convenient centres for over 2,000 acres. The season on the whole was favourable for the successful production of cotton, except in certain areas in Magam Pattu where unseasonal rains in January caused a reduction of the yield by affecting pollination of flowers. In areas where the normal rainfall was experienced good yields were recorded. The average yield per acre for the entire extent under cultivation was 5 cwt. Chenas rich in organic matter and those that received a good burn recorded a yield of 7–8 cwt. of seed cotton per acre. In some plots yields of over 10 cwt. per acre were not uncommon.

The general standard of cultivation was better than in the previous season. Growers are beginning to realise the benefit of clean production both in regard to cultivation, picking and grading of the crop. Cotton was grown generally as a pure crop. In bigger tracts, however, cotton was grown as a pure crop in rotation with crops of chillies, maize, kurakkan, sorghum, mustard and gingelly. A few cultivators had raised a crop of mustard as an associated or intercrop between rows of cotton spaced 4′ × 4′ apart and in the row. Yields up to 4 bushels per acre of mustard seed valued at Rs. 150 were produced without adversely affecting the yield from the cotton plots. Thus by the judicious introduction of a suitable cereal as an associated crop these cultivators were able to supplement their incomes from the cotton plots. It is pleasing to record the almost entire absence of pests and diseases in cotton during this season. This could be attributed not only to favourable weather conditions, but also to the attention paid to clean weeding of plots and clean picking of bolls.

Elaborate preparations were made this year regarding the Village Cotton Purchase Scheme in view of the large acreage involved and the large output of cotton—Nissen huts were procured with considerable difficulty and installed at some of the centres where stores were not available. Two such huts were installed at each centre, one for conducting the purchase and for storing cotton and the other for accommodating the staff for the duration of the purchase. Two new 3-ton lorries were purchased and the services of many others were obtained. A station waggon was also procured to enable the writer to carry cash from the Kachcheri to the purchase centres almost daily. Police escorts were provided at each centre. Consequent on this planned organisation the purchase was conducted without a hitch.

The only unsatisfactory feature was the inability to dispose of the crop to the Mills expeditiously owing to lack of sufficient storage facilities there. The Mills were in a position to take in only 500 bags of seed cotton per week, whilst the purchase rate per day was about 1000 bags. This necessitated the

storage of cotton at different purchase centres for an unduly along period The cotton was thereafter despatched to the main store in Hambantota to await its final despatch to the Mills. The despatch of cotton was finally closed after five months from the date of purchase. This involved considerable expenditure in connection with transport, handling and watching with the result that a deduction of Rs. 4–5 per cwt. was made at the purchase in addition to a deduction in weight allowed for driage in the store for so long a period. Thus the advantage of an enhanced price offered for seed cotton was vitiated by these reductions. The remedy therefore is the early installation of another store at the Mills which could take in all the cotton within a few days of completion of the purchase. It is hoped that this would be available in time for the next Purchase Scheme in 1950.

Cotton Purchase Statement for the Season 1948/49

Centre	Number of Cultivators	Purchase	Grade I Number of Bags	Grade I Quantity Cwt.	Grade I Quantity lbs.	Grade II Number of Bags	Grade II Quantity Cwt.	Grade II Quantity lbs.	Amount paid to Cultivators Rs.	Amount paid to Cultivators c.	Total amount paid Rs.	Total amount paid c.
1. Angunukolapelassa	241	1st	1,626	1,244	29				33,582	0		
						5	3	12	33	33		
		2nd	43	25	24				679	44		
						28	12	83	131	11	34,425	88
2. Barawakumbukka	126	1st	1,339	1,000	10				26,990	88		
						—	5	103	62	84		
		2nd	226	145	102				3,935	04		
						76	35	07	369	51	31,358	27
3. Middeniya	256	1st	1,330	975	81				26,330	28		
						12	4	34	46	16		
			26	15	82				423	72		
						44	20	74	211	61	27,011	77
4. Meegahajandura	134	1st	830	698	103				18,866	76		
						—	2	68	29	20	18,895	96
5. Mattala	100	1st	699	553	59				14,939	16		
						—	6	54	67	35		
		2nd	24	16	53				444	12		
						83	43	04	450	55		
Mattala paid at Kottakumbuka	3	1st	16	10	82	—	—		289	56	16,190	74
6. Gonnoruwa	59	1st	408	369	02				9,961	95		
						—	10	01	112	10		
		2nd	6	4	106				133	32		
						11	4	108	51	38	10,258	75
7. Ambalantota	56	1st	394	183	01				5,124	25		
						—	27	87	311	10		
		2nd	24	14	81				412	25	5,847	60
8. Bodagama	57	1st	325	259	67	—	—		7,268	75	7,268	75
9. Kotakumbuka	21	1st	152	119	79	—	—		3,351	75		
						2	1	52	16	95	3,368	70
10. Bata-ata	41	1st	123	75	93	—	—		2,123	25		
						23	6	44	71	60	2,194	85
11. Telulla	27	1st	80	50	08	—	—		1,402	0		
						—	1	55	16	70	1,418	70
12. Pelwatte	8	1st	58	26	100	—	—		753	0	753	0
13. Wellawaya	8	1st	36	19	39	—	—		541	45		
						—	1	26	13	80	555	25
14. Bundala	9	1st	23	7	104	—	—		213	31		
						—		102	10	20	224	1
15. Kinchigune	5	1st	4	2	21	—	—		58	80		
						1		20	1	80	60	60
	1,151	—	7,792	5,818	106	285	188	38	—		159,332	83

Cotton Growers' Union, Bodagama

A Cotton Growers' Union at Bodagama in Tanamalwila, Province of Uva, was sponsored by the Agricultural Production and Sales Society, Tanamalwila. Under this scheme about 100 acres were brought under cotton. Seed was supplied by the Range Agricultural Instructor. Cultivators were provided with cash advances for purposes of cultivation. Finally the crop produced by the members and other growers in the district was purchased by the Assistant

PLATE VI. (*Block by Survey Department.*)

PLATE VII. (*Block by Survey Department.*)

PLATE VIII. (*Block by Survey Department.*)

Registrar of Co-operative Societies, Province of Uva, and despatched to the Mills. In all a supply of 1,200 cwt. of seed cotton valued at Rs. 33,601 was purchased under this scheme. This arrangement was satisfactory for two main reasons. Cultivators had no need to resort to borrowing money from traders and middlemen for cultivation purposes and run the risk of having their potential crops mortgaged in lieu of cash borrowed. The Agricultural Officers were also relieved of the organisation involved in conducting a purchase in so remote a district especially in view of the large volume of work involved at a number of other centres. Co-operative schemes of this nature should be encouraged wherever possible as they are bound to promote better cultivation and greater production of cotton as an economic crop in village cultivation schemes.

Cotton Purchase Statement for the Season 48–49
(Conducted by Assistant Registrar, Co-operative Socities, Uva

BODAGAMA COTTON GROWERS' ASSOCIATION

Total Number of Cultivators	*Area*	*Total Quantity Purchased* Cwt. lb.	*Amount paid* Rs. c.
300	Bodagama and Tanamalwila (Province of Uva)	1,200 6	33,601 50

Progress of Cotton work at Wirawila Rotation Station and Hambantota Cotton Experimental Station

Cotton Rotation Station, Wirawila.—During the Maha season, 1948–49, the five-course rotation was altered to a four-course rotation and the land earmarked for a buffalo breeding station absorbed into the main rotation scheme. This was possible as it was decided to transfer the proposed buffalo breeding project to Ridiyagama where there were better facilities for such a project particularly a permanent supply of water and good pasture. With the addition of this new land and the curtailment of the rotation period, it was possible to multiply cotton (BP79) in an extent of 150 acres where only 60 acres had been grown before. In view of the extension of the village cotton cultivation scheme, it was necessary to bring a bigger area under cultivation at the rotation station for the purpose of raising sufficient pure seed for distribution under this scheme. Thus it was possible to raise sufficient seed for an extent of 4,000 acres for the Maha 1949–50 season. Actually only 136 of the 150-acre unit was brought under cultivation, making allowance for soil conservation drains, gullies, &c. The yield obtained was 49,531 lb., or an average yield of 364 lbs or $3\frac{1}{4}$ cwt. per acre. This is a fair average crop for a big extent of land where cotton was cultivated without an application of bulky organic manure. Cotton plots were treated with sulphate of ammonia at the rate of one cwt. per acre.

Cotton Experimental Station, Hambantota.—During the Maha season 1948–49, 14 varieties of medium staple cotton and one long staple cotton was grown in observation plots in an extent of 3·85 acres. The entire area received an application of 3 tons per acre of cattle manure only. The total output of seed cotton was $55\frac{1}{2}$ cwts. which calculated on an acerage basis yielded $13\frac{1}{4}$ cwts. This is an extremely high yield and demonstrates the advantage of organic manure on the cotton crop in lands under cultivation for many years.

Cotton Ginning.—During this year a small double roller gin imported from Messrs. Platt Bros., England, was installed at the Cotton Rotation Station, Wirawila. The object in view was to gin the BP79 crop raised at this station at the spot without having to send it to the mills in Colombo. By this innovation two important requirements have been served namely (*a*) Eliminating any possibility of the pure seed mixing at the Colombo mills, (*b*) Eliminating the necessity to withhold the village crop from the mills, until the rotation crop was sent there for ginning and the return of seed. The crop raised during 1948–49 season was expeditiously ginned in this newly installed gin, and thereafter the ginning of the Maha Illuppallama and Pelwehera crops amounting to 20 tons was undertaken.

It might be of interest to record the more important requirements in ginning with a gin of this type. It is important that the gin should not be fed too heavily, for as soon as the machine is overcharged the ginning at once ceases as the seeds from cotton already ginned form an effective barrier between the leather rollers and the seed cotton in the hopper. The system to adopt is to feed rather sharply and lightly always giving a full supply across the whole length of the rollers. The cotton should be fed with a lateral movement of the hand. This opens the cotton and prevents clogging or matting together.

Variety of Cotton recommended for Cultivation

The variety recommended for cultivation is BP 79, an Upland medium staple cotton from Uganda. It has stood the test of experimentation for many years under local conditions and has proved its worth. The cotton produced in this country has been favourably reported by the Cotton Technological Laboratory, Bombay, and the Shirley Institute, Manchester. Its staple length is $1\frac{1}{8}$ inches and is capable of spinning up to 60 counts. This variety is typical of the type used for over fifty per cent. of the world production. It was first introduced into the Rotation Station, Wirawila, during Maha 1944–45 where it was grown in "purity" plots. Seed from these plots was multiplied in a sixty (60) acre unit in the rotation scheme in the following season, when it was distributed for the first time for the village cultivation scheme during Maha season 1947 with conspicuous success.

Future Prospects of Cotton Cultivation

The cultivation of cotton in this division at present is on a sound footing. The prospects for the future are good. However, expansion of this agricultural enterprise as an economic undertaking in rural agriculture would to a great extent depend not so much as a shifting system of chena production but on a settled system of rotational agriculture. Cotton should be introduced in a system of alternate husbandry or ley farming where livestock play an important part in the cultivation scheme. In dry zone agriculture where preservation of soil fertility is an important consideration owing to the weathering action of sun and wind after the Yala season for about four months followed by precipitation of rain for about two months during the Maha season, it is of paramount importance to preserve soil fertility. This could be achieved by adopting an effective system of soil conservation and enriching the soil by cattle penning and incorporation of cattle manure and compost. The

value of cattle manure in land subject to annual cropping under dry zone conditions has been clearly demonstrated in the high yields obtained from cotton plots at the Experiment Station, Hambantota, during Maha season 1948.

The assurance of a guaranteed price and a ready market for the crop was an incentive to greater production of good quality cotton and adoption of better methods of cultivation. In order to encourage the picking and marketing of clean cotton it is advisable to offer a low price for dirty and stained cotton.

The economic production of cotton is important if the industry is to be developed on a proper basis. This may be achieved by (*a*) Increased mechanisation and improved methods of cultivation, (*b*) Higher yields, (*c*) Greater economic use of bye products for cattle food and fertilizer, (*d*) Greater local manufacture of yarn and cotton goods as a cottage industry.

2—J. N. A 94258 (12/49)

The Performance of the Salt-Resistant Paddy, Pokkali in Ceylon

L. H. FERNANDO, B.Sc. (Lond.),

AGRICULTURAL RESEARCH OFFICER, SOUTH-EASTERN DIVISION

THE salt-resistant paddy *Pokkali* was obtained from the Economic Botanist, Nagercoil, Travancore, in 1938. It was first sown at Ambalantota Paddy Station in the *maha* season of 1939. The first observations were made on small plots. One acre of a saline field was sown in *maha* 1942 and yielded 37 bushels. In the following *yala* season, 1943, 28 bushels were obtained from an acre. The variety appeared promising and was first recommended for cultivation in 1945, on a request from the Assistant Government Agent, Chilaw, for seed of a salt-resistant variety. The variety proved so successful that its cultivation rapidly spread. It now covers a considerable extent of saline land along the west coast of the Island, particularly in the Muturajawela area.

Trials with *Pokkali* continued at Ambalantota Paddy Station. Replicated field experiments were set down and *Pokkali* was tested against the salt resistant varieties, *Kagga*, *Bile Kagga*, SR 14, SR 26B, *Uvar Karuppan*, and *Uvar Vellai*. *Pokkali* was the best of these paddies, but no significant differences between varieties could be demonstrated on account of considerable variation in the stand of plants from plot to plot. Variability in stand was caused by the irregular distribution of salinity within blocks. Differences between blocks were even more marked. Soil samples taken from adjacent blocks in *yala* 1945 were examined and reported on by the Chemist as follows :—

TABLE I

Salt per cent. and pH value of saline soils at Ambalantota Paddy Station, Yala, 1945

Blocks	*pH value*	*Percentage of total salts*
1	7·1	0·23
2	6·4	0·42
3	6·2	0·33
4	6·6	1·50
5	6·7	0·17

Soil samples were again taken from the same blocks in the next season, *maha* 1945/46 and were found to contain the following percentages of sodium chloride :—

TABLE II

Salt per cent. and pH value of saline soils at Ambalantota Paddy Station, Maha 1945/46

Blocks	*pH value*	*Percentage of sodium chloride*
1	6·66	0·47
2	6·61	0·41
3	6·24	0·26
4	7·88	0·90
5	6·96	0·19

The salinity of block 4 was particularly high ; a number of varieties sown in this block in *maha* 1945/46 failed altogether. In this season, 1½ acres planted in *Pokkali* yielded 84 bushels, *i.e.*, the yield per acre was 56 bushels. The extents and yields of *Pokkali* in subsequent seasons are given in Table III.

TABLE III

Yield of Pokkali Paddy at Ambalantota Paddy Station

Years	*Yala*		*Maha*	
	Extent in acres	*Acre yield in bushels*	*Extent in acres*	*Acre yield in bushels*
1946	3	33	2	29
1947	2	17	2	27
1948	2	25	5	25
1949	5	35	—	—

Damage by stem-borer (*Schoenobius bipunctifer*) was responsible for the low yield in *yala* 1947. In *yala* and *maha*, 1948, *Pokkali* was transplanted. The other yields listed above relate to broadcast *Pokkali*. All the yields given above were obtained without application of organic manures or artificials.

The records given in Table IV show that *Pokkali* flowers three weeks earlier in *maha* than in *yala*, and suggest a high degree of sensitiveness to the photoperiod.

TABLE IV

Duration in days from sowing to flowering

Year	*Yala*	*Maha*
1945	86	72
1946	92	69
1947	85	68
1948	95	68
	—	—
Mean	89	69
	—	—

The figures for 1948, both *maha* and *yala*, refer to flowering of transplanted fields. Transplanting did not appreciably extend the duration from sowing to flowering. Sowing-date and transplanting effects on age are of particular interest in the Muturajawela tract where floods provide as serious a problem

as salinity. *Pokkali*, on account of its short age, succumbs to floods. No salt-resistant paddy is likely to succeed in the Muturajawela area unless its sowing-to-harvesting duration is extended to five months.

Experience at Muturajawela indicates that on the very acid (pH value : 4·0) peaty soils of the tract, the maximum salinity that *Pokkali* tolerates does not exceed 0·22 per cent. Salt, among other things, inhibits germination. Seed paddy should be well-sprouted, and plumules and radicles fully developed before sowing. It is also desirable to delay sowing till the early rains have reduced soil salinity. In estimates made by the Chemist in 1948, it was observed that a delay of one month effected a reduction in average salinity of soil water from 0·15 per cent. on May 16, to 0·07 per cent. on June 17. *Pokkali* was introduced to Muturajawela in 1947. It is premature to pronounce on the potentialities of *Pokkali* in the tract, but the yields so far obtained in areas subject to floods have been depressingly low.

The variety *Pokkali* is characterized by the complete absence of anthocyanin pigment, by its broad leaf, by the pale straw-coloured fertile glumes and by the short, white, sterile glumes of the mature grain. At flowering the fertile glumes are yellowish-green and slightly hairy ; the sterile glumes are green at the base and unpigmented above. The grain is awnless. The rice colour is red with abdominal white. The peduncle is well exserted, the panicle is not compact and the flag leaf is erect to oblique. The tillers are erect. Salt-resistance is, of course, the most conspicuous virtue of *Pokkali*. The variety possess, in addition, a high degree of lodging and shedding-resistance. *Pokkali* does not resist floods.

The quantitative characters are expressed in Table V.

TABLE V

Quantitative Characters of Pokkali

	Mean	*Standard error of the mean*
Height ..	60·0 inches ..	± 0·79
Tiller number ..	6 ..	± 0·63
Panicle length ..	10·1 inches ..	± 0·27
Grain length ..	8·63 mm. ..	± 0·0327
breadth ..	3·54 „ ..	± 0·0123
thickness ..	2·35 „ ..	± 0·0153
Rice length ..	6·19 „ ..	± 0·0210
breadth ..	3·08 „ ..	± 0·0121
thickness ..	2·10 „ ..	± 0·0095

The height measurements relate to Ambalantota conditions. The plants are much shorter at Muturajawela. Grain measurements were made on a random sample of 200 grains. Figures 1–6 represent the frequency distributions of length, breadth and thickness of husked and unhusked grain. Frequency is represented on the vertical ordinate as a percentage, and the dimensions are expressed in millimetres along the horizontal ordinate.

The irregularity of the curve of length of unhusked grain (Figure 1) and the wide range between the lowest and highest values of grain length suggest that *Pokkali* is possibly not a pure line. The standard error is 0·37 per cent., a figure not markedly higher than that for pure-line paddies. Genetic variability does not appear to be sufficiently high to warrant selection within the variety.

The Science of Genetics

BY

ALAN ROBERTSON

INSTITUTE OF ANIMAL GENETICS, EDINBURGH

(*Extracted from the Guernsey Breeders' Journal, Vol. 2 No. 4, Winter, 1948*)

THE science of genetics, or the theory of inheritance, has had surprisingly little application in the field of applied breeding although the fundamental mechanism of inheritance has been well understood for many years. The main reason for this is that the characters most easily studied in the laboratory are those controlled by single genes (the unit of inheritance), and whose measurement is simple and clear-cut. Examples of such genes in cattle are those controlling red colour as against black, polled as opposed to horned, and also those controlling blood groups. Blood grouping in cattle has now reached the stage where cases of doubtful parentage can be settled with almost complete certainty and it is actually being used for that purpose by Guernsey breeders in America. Breeding for such characters as colour or lack of horns is comparatively simple, as it is fairly easy to decide which genes a given animal possesses. But when the scientist comes up against characters whose expression is controlled by more than two or three genes, the picture becomes entirely different. Almost all characters of economic importance in farm animals fall into this group—milk yield, fat percentage, rate of growth, and so on, and there is the additional complication that the measurement of the effects produced by the genes is no longer as clear-cut as deciding whether a cow is red or black. The 305-day yield is affected by many external factors that have nothing to do with a cow's breeding value—trouble at calving, infections, and so on. This leads to a situation far removed from that which the geneticist usually has to deal with in his laboratory. And it involves a completely different approach for him—one which often gets involved in complicated mathematics. However, the necessary techniques have been slowly built up and the stage has now been reached when some help may be given to the practical breeder. It is the intention of this article to show the geneticist's point of view and to indicate the application of the method to one or two breeding schemes.

Before the breeding method can be discussed, it must be made clear what we are breeding for; I would define this in dairy cattle as the economic production of milk and fat under commercial conditions. Included in this will be such characters as longevity, which influence the profitability of milk production. In this article, I shall be referring mostly to milk yield and fat percentage. It will be assumed from the beginning that all these characters are controlled by a large number of genes—the exact number being unimportant. The first step is to clear out of the way the variation caused by

external factors we know to affect milk yield—age, month of calving and preceding dry period. We will then correct for these factors, after determining their effect, and use the corrected yield for the genetic investigations. The next and most fundamental step in the geneticist's approach is to discover to what extent the corrected performance reflects breeding value. We can compare the breeding value of any two groups of cows by looking at the performance of their daughters by the same bull. Suppose we take all the daughters produced by a bull (all the daughters being in the same herd) and divide them into two groups according to the yield of their dams in the first lactation. Now the difference between the groups of daughters will be due to the genes contributed to the two groups by their mothers, since the sire will, on the average, contribute the same to the two groups. But this difference is only half the difference between the breeding value of the dams in the two groups, since they contribute only half their daughters' genes. In practice, we find that for 100 gallons difference between the groups of dams, there is 12 gallons difference between the daughters, i.e., 24 gallons difference in breeding value of the dam's groups. It means that, after correcting for the obvious external factors that affect yield, the difference in breeding value of any two cows is still only one-quarter of their difference in performance. In other words, only one-quarter of the variability of corrected yield is due to genetic causes and the remaining three-quarter is due to intangible differences in the surroundings of the cow, even though all cows have had the same treatment as far as the cowman is concerned. For fat percentage, the figure for the genetic variability is higher, probably accounting for about half of the total. This fraction, the proportion of total variability in corrected performance that is due to differences in breeding value, is of fundamental importance in the new approach and is called the "heritability" of the character in question. There are some breeders who, having realized that performance is a poor measure of breeding value, have gone the whole hog and denied any connection between the two at all. However, the above direct measurement of "heritability" in which the figures are drawn from actual results, contradicts this assertion.

So far, we have only discovered what happens inside a herd, in which, as far as the cowman is concerned, all cows get the same treatment. But nobody would dispute that, as far as concerns differences between herds, differences in management can play a very large part. For the comparison of records made in different herds, it is necessary to estimate the reliability of the herd average as a measure of the breeding value of the herd. As yet sufficient evidence is not available in this country to make a reasonable guess. However, the records from cows produced by artificial insemination by the same bull in different herds, now available from several A. I. stations, suggest that herd average is not a very accurate measure of the genetic level of the herd. Results from U. S. A. and New Zealand on progeny testing indicate that about one-quarter to one-third of the differences between herd averages is due to differences in genetic merit. The figure for fat is probably higher. It is well known that it is more difficult to put up fat by skilful management than it is to put up yield. In England and Wales, the picture is complicated by differences in local conditions which cause, roughly, high yield and low fat in the east and the reverse in the west. The whole question of the relation between the performance and breeding value of herds is one which needs

much further work. It is obviously of the greatest importance in evaluating pedigrees to get some method, even if only approximate, of allowing for the management level of a herd.

Within a herd, at least, the picture is fairly clear and it is possible to make use of the estimates of heritability to calculate the genetic gains possible by various methods of breeding. In this approach, we shall always be dealing, for instance, with the "average result" of a certain course of action or with the average yield of the progeny from a bull chosen in a certain manner. Even though the breeding value of the two parents is exactly known, it is impossible to predict the performance of any individual offspring with any certainty. One has only to look around to see the great differences there are between full brothers. This is partly due to the fact that all offspring do not receive the same genes from their parents and partly due to the large amount of variability from nongenetic causes. We will first consider a closed herd (i.e., one in which there is no importation of breeding stock) of sufficient size to avoid close inbreeding say 100 cows. The normal method of improvement can then be split into two—

(i) culling of low producers;
(ii) breeding of bulls from the best cows in the herd.

The possibility of the culling of low producers depends, of course, on the natural wastage rates in the herd. A distinction also arises between the breeder and the milk producers. It would seem profitable for the farmer to do all his culling early, say before the end of the second lactation, disposing also of all offspring of the culled animals and breeding from those retained, as long as they will live.

The producer, on the other hand, should cull entirely on the basis of the immediately previous lactation. In fact, the distinction between the two types of herd is far from rigid and most people carry out a mixture of the two policies. We will consider a breeder with a herd average of 800 gallons, who does all his culling on first lactation records and who feeds all available heifers into the herd. He would then dispose of about half his heifers after their first lactation, with the result (assuming that all his culling was for reasons of yield) that he would be breeding from cows which were about 100 gallons better in performance than the average of cows born in the same year, that is 25 gallons better in breeding value. He can breed bulls from the best cows in the herd, say the best 5 per cent. which means cows about 300 gallons better in performance than their contemporaries, giving a superiority of 80 gallons in breeding value. The offspring will receive half of these benefits—the heifers will be 12 gallons better and the bull calves 40 gallons better. So the animals born to be used for further breeding will be on the average $\frac{40+12}{2}=26$ gallons better than those born one generation before. As a generation in dairy cattle is 4–5 years, this means a genetic improvement of about 5–7 gallons a year. It must be emphasized again that this is an average value—it is what you would get if you carried out the same policy on several herds and took the average. Some would be lucky with bulls and some would not. Of this increase, about one quarter would

...conditions existing here predominate—the next would be from breeding bulls from good cows. Such closed herds are not very common, due to the interesting limitations we also said, as in buying a bull from outside one is presumably ...ess informed about his probable worth than if he was home-bred, this assurance is probably higher than the average rate of improvement over the whole country. The only herd that we have thoroughly analysed gave a probable improvement of 2-3 gallons per year although these low figures are partly due to much involuntary culling of cows.

Some notes on animal breeding in relation of the apparent lack of connection between performance and breeding value, have suggested that the progeny test may provide a possibility of rapid improvement. This is undoubtedly true, subject to certain conditions. From the genetic point of view, the progeny test is a method of increasing the accuracy of measurement of the breeding value of a bull, with the double advantage of using him as a sound older animal and thus increasing the generation length. Reducing both to the calculation of the rate of gain in a closed herd, the rapid improvement is increased but in its new relation to those annuals born 1 or 2 years back instead of 4 to 7. As the breeder is interested in rate of improvement per year these two points are in conflict. It is roughly analogous to the dilemma of whether to take a shipping train leaving immediately or to wait two hours for the express. It is often assumed in discussions of progeny testing that the yield of 10 or 20 daughters gives sure measure of the bull's breeding value. But just as we can speak of the certainty of a cow's record, so we can speak of the heritability of a bull's performance. Suppose we pick out all bulls whose 10 daughters averaged 100 gallons better than their dams and their dams were average for the breed and use them again. Then their second lot of daughters will average 50 gallons better than their dams. In picking out those bulls with a good performance, we have chosen partly those whose daughters were favourable in their environment and partly those really superior in breeding value. In other words the difference in breeding value of bulls judged on 10 daughters is only 1-2 of the difference in performance. The corresponding figure for a judgement on 20 daughters is 1-3. These figures for the heritability of a bull's performance are derived directly from the figure of one quarter for the heritability of a cow's single record.

In the consideration of any scheme for progeny testing, we can vary a [illegible] factors. We can list them as follows —

(i) the size of the breed unit;
(ii) the extent to which tested bulls are used;
(iii) the number of bulls tested;
(iv) the number of progeny tested per bull;
(v) the age of the bulls at testing.

The answer to the last question is obvious. Bulls must be tested at as early an age as possible to cut down the generation length and also to reduce losses between testing and former use, with increase the period of further use. The other questions require some thought. Some American workers have considered the matter of progeny testing in a closed herd of smaller size to that discussed above and have concluded that progeny testing was not economical there. In a small herd the number of progeny required

to test a bull with any accuracy cuts down the number of bulls that can be tested (one may have to select one out of three) and also the proportion of the herd on which the tested bulls could be used. All in all, the testing does not pay for the increase in generation length.

It would seem obvious that if bulls are to be selected after considerable trouble, they must be used on the widest possible scale. This means artificial insemination and, if we are to avoid inbreeding, we need at least two bulls per unit, a minimum size of 2,000 cows. Calculation shows that the best structure for such a unit would be somewhat as follows:—

(i) the usual culling of low producers;

(ii) about 7 bulls out of the best cows in the unit, to be tested per year;

(iii) each bull to service 60 cows which may be expected to give 20 heifers in-milk in about 3 years;

(iv) two tested bulls to be used on the rest of the unit (the testing will occupy about one-fifth of all cows). It is assumed that each tested bull will be good for three years further life. The wastage of bulls needs further investigation.

A Unit with this structure will give a probable improvement of around 10–12 gallons per year. Of this amount, about one-third comes from the first selection of bulls for testing from the best cows in the unit. Without this, progeny testing would apparently not be much more valuable than the normal selection outlined above. It seems probable therefore that progeny testing will be valuable if done on a sufficiently large scale and give improvements at about twice the rate expected by normal selection. However, progeny testing will not be valuable on small units of size around 200 cows. 2,000 cows would seem to be the minimum.

This argument has been built on what may appear to some to be a very shaky foundation. It is reasonable to ask what practical evidence there is as to the validity of such conclusions. Obviously, it is very difficult to test them in part because of time. However, similar calculations of the probable improvement have been made in pigs and poultry, where the generation length is much less, and in both cases the actual gains were very close to those expected.

This brief article has indicated the approach that geneticists are now using in connection with animal breeding and has shown its application to the question of progeny testing. There remain many topics with which there has not been time to deal, such as pedigree evaluation, mating, and the different systems of mating such as inbreeding and line-breeding. Most of the examples used have been taken from American data. However, a large survey of the genetics of milk production is now under way in this organization, and the records of several of the leading Guernsey herds in the country have been kindly loaned to us by their owners and are included in this work. It is hoped that the results from this investigation, which at the present give the same general picture as the American results, will help in solving the problems which are arising in dairy cattle breeding in this country.

Deep Tillage

BY

E. W. RUSSELL, ROTHAMSTED EXPERIMENTAL STATION

EXTRACTED FROM THE "AGRICULTURAL ENGINEERING RECORD," SPRING, 1948

DEEP tillage has been practised in parts of Britain for nearly 200 years on light sands, and for 100 years on heavier soils, although it was a very laborious operation until the introduction of the steam engine to the farm over 80 years ago. Deep tillage has become even easier during the past 20 years with the introduction of large track laying tractors. In spite of its long history, deep ploughing is still an operation on which different successful farmers, farming on apparently similar soils and following the same general methods of farming, hold diametrically opposed views. It would therefore appear that deep ploughing can be of benefit only under certain conditions, for otherwise it would not be possible for competent farmers to be in disagreement on such an essential part of the technique of cultivation. There is still very little knowledge of just what consequences deep tillage, either subsoiling or deep ploughing, has on a soil or crop, and it was to learn something about the subject that the Agricultural Improvement Council, with the encouragement of the Agricultural Research Council, initiated a series of deep tillage experiments that are being carried out on farms all over the country. These experiments were started in the autumn of 1944, and only slowly can the consequences of the various effects deep tillage has on the general management of arable land be unravelled.

In this article, deep tillage operations are considered as falling into two groups: those that are primarily subsoiling, or the loosening of the subsoil without bringing it to the surface; and those that are primarily deep ploughing, or the inversion of the soil so that much of the subsoil is brought to the surface. In practice, the division is not always quite so clear cut, as on the one hand the design or equipment of the plough can be changed to allow a greater or lesser proportion of the surface soil to be buried deeply, and on the other hand there are implements such as the gyrotiller that can be regarded mainly as subsoilers but are capable of bringing up varying proportions of subsoil to the surface.

Deep tillage has one obvious consequence. The soil is loosened and the number and size of the large pockets of air in the soil are increased. If the base of the loosened layer is impermeable to water, and rain follows the deep tillage before the next crop is able to use much of the water, the air pockets will become full of water, and the soil will be turned into a marsh. Hence, the first point that should always be borne in mind is that deep tillage must only

be practised on drained land. Land with impermeable subsoils, or high water-tables, must never have the subsoil loosened. However, deep tillage, whether subsoiling or deep ploughing, can improve drainage by increasing the size of the air spaces in the soil, provided that the water percolating through the loosened layer can get away into drains or into deep ground water. It is not yet known if subsoiling and deep ploughing are equally effective for this purpose, but it is possible that deep ploughing is the more reliable method of improving the ease of drainage. When the subsoil is dry, subsoiling is probably as efficient as deep ploughing in this respect, but in some years this condition occurs only in summer and under a standing crop. Also, it is possible that on some soils such as silts, where the soil particles run together easily, deep ploughing, by bringing the subsoil to the influence of the sun, mellows it so that the clods when wet do not run together as easily as they did when they were in the subsoil. However, these points of difference between subsoiling and deep ploughing as they affect drainage have not yet been proved by rigorous experiments. Deep tillage can increase the air content of the subsoil, and hence improve the aeration of the soil around the roots of plants.

It can also increase the amount of water the soil can hold when it becomes water-logged; but it cannot increase the amount of water a well-drained soil can hold, that is usable by crops. If deep tillage improves the drought resistance of crops, it is for reasons other than this.

Deep ploughing differs from subsoiling in that the surface soil is buried under a layer of subsoil. This has three distinct consequences: surface weeds and weed seeds are buried deep; the deep roots of pernicious perennial weeds, such as dock and thistle, are brought to the surface; and manure, lime, fertilizers, or more fertile friable soils, are distributed through a deeper layer.

The power of deep ploughing to control weeds can be remarkable. In all the experiments recently carried out in England, deep ploughing—ploughing, that is, from 4 to 6 inches more than the customary depth—has never brought up weed seeds, although ploughing that has been only 1 or 2 inches deeper than usual has brought up many buried seeds. When some strips of land have been ploughed deep and others shallow in autumn, the shallow ploughed strips have sometimes been green in spring while the other strips have always been practically free from weeds, provided that the ploughing has been done well. In several areas the chief difficulty of making a good job of deep ploughing is that the subsoil sticks to the mouldboard. Also, it is difficult to set some multi-furrow ploughs to bury all surface weed seeds and rubbish very deep, because they cannot be set to cut a sufficiently wide furrow for good inversion when they are working deep, although the depth may well be within the capability of the mould-board. The power of autumn deep ploughing to give cleaner land in the spring can be of very great value if for any reason a farmer is late with his spring work, as was frequently so last year; he is able to prepare the top few inches of surface soil into a seed bed rapidly, without risk of it drying out. An example of the benefit of this extra cleanness of the soil is furnished by deep ploughing experiments at Rothamsted in the spring of 1947. The land to be sown with sugar-beet was worked quickly and apparently well, and was drilled in late April. However, annual weed seeds germinated with the sugar-beet on plots ploughed 6 inches deep, while

none germinated on those ploughed 12 inches deep. Although germination was rather slower and not so even on the plots ploughed deep, the beet grew quicker than that of the shallower ploughed plots, even though the latter plots were horse-hoed, singled, and hand-hoed, as early as possible, and at harvest, probably largely in consequence of the freedom from early weeds, the yields of beet on the deep ploughed plots were over 3 tons an acre higher than on the other plots. This greater freedom from weeds often persisted throughout the season, although there always were some fields where they appeared worse on the deeper ploughed plots. These differences from the usual behaviour, however, were noticed only in the summer and not in the spring.

A second possible consequence of deep ploughing is that it enables nutrients to be incorporated more deeply than when shallow ploughing is practised. This effect is important only when the nutrients cannot move easily in the soil, and therefore applies to lime, potash, phosphate, and farmyard manure, but not to nitrogen. These materials fall into two classes: lime and plant foods. If the subsoil is very acid, the spreading of lime on the soil surface, followed by deep ploughing and a further spreading of lime, will quickly sweeten a much greater depth of soil than if the lime were incorporated in only the top few inches of soil. The advantage of sweetening the soil in this way can be very striking in short periods of drought, for deepening the sweetened layer of soil allows the roots to penetrate more deeply and to take more water from the soil. The depth to which farmyard manure is ploughed-in the soil seems to have no effect on its value to the crop. In the Rothamsted experiments, farmyard manure that was spread on the land in the autumn and then ploughed-in either 6 or 12 inches deep increased the yield of potatoes and sugar-beet equally for both the deep and the shallow ploughed plots. The responsiveness of the crop to potash and phosphate may depend on the depth to which these nutrients are ploughed-in.

It would be thought that deep incorporation of these fertilizers would benefit during dry periods those crops, such as sugar-beet, that grow fast in mid-summer, for plant roots can only extract their food from moist soil, and during a dry period the crop tends to dry the soil from the surface downwards. Hence the deeper the fertilizer is placed in the soil, the longer it will remain moist and the longer it will be available to the growing crop. If this is correct, it would be expected that the poorer the subsoil the more desirable it would be to plough the soil deep, in order to bury the nutrients in the subsoil and make it possible for the poor soil brought up to be enriched. Yet these are the very soils that many farmers, who practise deep ploughing, suggest should not be ploughed deep, or at least, should be increased in depth only slowly year by year.

The experimental results so far obtained are not yet numerous enough to be conclusive, but they suggest that yields of sugar-beet can be increased if potash and phosphate are applied in the autumn instead of the spring and the land then ploughed between 6 and 9 inches deep. In 1946, autumn ploughing-in of fertilizers on some soils increased the yield of beet by a ton an acre, which is not a poor reward to receive for the extra trouble of having to drill potash and phosphate in the autumn, and nitrogen in the spring. However, on land ploughed to 12 inches or more in depth the results have been much more erratic, possibly because not enough care had been taken to

ensure that adequate quantities of fertilizer were added to the seed bed, which was composed mainly of weathered subsoil, to overcome the harmful effects of its poverty. There is some evidence that on land with a poor subsoil, crops will respond more profitably to large amounts of phosphate and potash if the soil has been ploughed deep, provided the fertilizer is given in two dressings, one before and one after the ploughing.

CONCLUSIONS

Deep tillage should only be practised on drained land. If the field has a drainage system already installed, or has a naturally free-draining subsoil, deep tillage will often increase the speed of drainage. There is an indication not yet well established that deep ploughing is rather more efficient than subsoiling for this purpose.

Deep ploughing usually gives a better control of weeds in the early part of the growing season, and in consequence may allow spring-sown crops to be planted earlier with less loss of water from the seed bed than is possible on shallow ploughed land.

Deep ploughing enables the depth of fertile soil to be increased. It has not yet been possible to demonstrate rigorously under what conditions this extra depth results in increased yield.

Provided that adequate fertilizer is added to the seed bed to ensure that it is not too poor, that the field is well drained, and that the subsoil does not consist of broken pieces of limestone or large lumps of solid chalk, there is no indication that deep ploughing will depress crop yields no matter what kind of sand or clay is brought up. It is not therefore a dangerous operation under the conditions specified.

PROCEEDINGS OF THE SECOND MEETING OF THE CENTRAL BOARD OF AGRICULTURE HELD IN THE BOARD ROOM OF THE SUISSE HOTEL, KANDY, ON MAY 16, 1949, AT 2.30 P.M.

MR. D. Rhind, the Director of Agriculture, presided and the following were present:—Hon'ble Mr. Dudley Senanayake, Minister of Agriculture and Lands, Senator Col. T. Y. Wright, Sir Wilfred de Soysa, Mr. Thomas Amarasuriya, Chairman, Low Country Products Association, T. B. Poholiyadde Dissawa, M.P., Mr. S. Sivapalan, M.P., Mr. W. M. Cumaraswamy, Mr. E. Muttukumaru, Mr. S. F. Amarasinghe, Land Commissioner, Rev. Fr. L. W. Wickremasinghe, Mr. Wilmot A. Perera, M.P., Mr. Marcus S. Rockwood, Mr. A. M. Clement Dias, Mr. A. Perumynar, Mr. H. Abeygoonesekera, Mr. H. A. Peiris, Divisional Agricultural Officer, Tangalla, Mr. U. B. Dedigama, Dr. M. F. Chandraratne, Botanist, Dr. W. R. C. Paul, Agricultural Officer, Head Office, Mr. C. N. E. J. de Mel, Acting Deputy Director of Agriculture, Mr. P. G. Malkani, Acting Deputy Director, Animal Husbandry, Major E. C. de Fonseka, M.B.E., E.D., P. B. Bulankulama Dissawa, J.P., U.M., M.P., and Parliamentary Secretary to the Minister for Agriculture and Lands, Mr. R. T. Chelliah, Mr. A. Hensman, Mr. W. P. A. Wickremasinghe, M.P., Gate Mudaliyar M. S. Kariapper, J.P., U.M., M.P., and Parliamentary Secretary to the Minister of Home Affairs, Gate Mudaliyar N. Wickremaratne, Senator C. A. M. de Silva, Mr. S. A. I. Elapata, M.B.E., J.P., U.M., A. E. Madawala Dissawa, Mr. S. L. B. Dharmakirti, J.P., Sir James P. Obeyesekera, Mr. B. L. W. Fernando, Marketing Commissioner, Mr. S. C. Fernando, Registrar of Co-operative Societies, Mr. S. G. Taylor, Director of Irrigation, Mr. E. Abeyratne, Agricultural Research Officer, Maha Illuppallama, and Mr. H. E. S. Ranasinghe, C.C.S., Secretary, Central Board of Agriculture.

The following visitors were also present:—Dr. A. W. R. Joachim, M.B.E., Dr. B. A. Baptist, Entomologist, Agricultural Department, Mr. M. Srikhanta, Additional Director of Land Development, Dr. J. W. L. Peiris, Plant Pathologist.

Letters and telegrams regretting inability to attend the meeting were received from the following members:—

Mr. U. B. Unamboowe, Mr. D. A. B. Ratnayake, Mudaliyar Abulcassim Marakar, Hon. Mr. H. W. Amarasuriya, Minister of Commerce and Trade, Mr. K. V. D. Sugathadasa, M.P., and Mr. R. H. Spencer-Schrader.

The Chairman said that the subject for discussion was Food Production and besides the Confirmation of the Minutes of the last meeting, no other subjects would be taken up for discussion at this meeting.

I.—CONFIRMATION OF THE MINUTES OF THE LAST MEETING.

The minutes of the previous meeting were confirmed subject to certain amendments suggested by two members and accepted by the meeting.

II.—FOOD PRODUCTION.

The Chairman invited the Hon. the Minister to initiate the discussion.

The Hon. Mr. Dudley Senanayake initiating the discussion said that he had thought that this should be a meeting at which he should listen rather than speak. But, however, the Chairman had requested him to initiate a discussion on a very important topic to which the members had thought fit to address their minds that afternoon. He did not think many words of his were necessary to impress on members the importance of the subject brought up for discussion that afternoon. He emphasized that today we were spending about 500 million rupees in the import of essential foodstuffs. Compared to our annual national income, this was a very high proportion indeed. This problem, he said, was not one facing our country alone but seemed to be a very serious one facing the world as a whole at the present moment. Populations have increased at terrific rates but unfortunately the produce of the land does not seem to keep pace. He said he would very briefly review the present position and indicate to members the lines on which it is proposed to tackle these problems and that a discussion on those topics could ensue later. When we talk of food in Ceylon we turn our minds firstly to rice production. We are well aware of the fact that we have to depend on other countries for the major portion of our essential staple diet and the ways in which we could tackle this problem could be divided firstly into two categories. On the one hand it is to bring as many acres of land under cultivation and on the other hand to step up the yields of every cultivated acre in this country. As members know, if they look at the problem of this country today, it has to be tackled on both those lines and there is every possibility of tackling it on those lines. As regards the bringing of new land under cultivation, he said that members were well aware of the endeavours made to open up new land in the most suitable areas and that that process has necessarily to be slow. It meant firstly the inauguration of vast irrigation schemes; clearing of jungle areas, building of suitable houses and the settling of colonists. Spade work in that direction had been started some years back and he was glad to be able to say that a good deal of headway has been made and today the problem was not one of inducing the people to go and inhabit those areas but the problem was to meet the demand for bringing more land under cultivation and to cope with it. As regards village irrigation schemes, every endeavour was being made to step up the construction of those minor irrigation works with the intention of bringing more land under cultivation. But there was still the very important problem of stepping up the existing yields which he admitted were very poor indeed when compared with the yields of some other countries. Firstly, endeavours were being made by trying to inculcate in the minds of the cultivators better methods of cultivation amongst which various drives of various sorts such as transplanting was encouraged with a great deal of vigour by the Department of Agriculture, and he was glad to hear of some of the results they have been able to obtain in their transplanting. Then there was an endeavour made to step up yields by such measures as the use of high yielding pure seed material. In that direction, he confessed, they had a long way to go still. To a certain extent they have been limited by the available extent of land under their control for the purpose of multiplication and an effort had been made to get over the difficulty by utilization of private seed farms for the purpose.

Then, on the question of manure, the Hon. Minister of Agriculture and Lands, said that hitherto, the gentlemen present were aware, there had been a free distribution of bone-meal manure. The price at which this manure was available had increased at such a rate that the purchase of the necessary 24,000 tons was costing the Government about Rs. 8 million. So unfortunately, the Government was compelled lately to decide to discontinue the free issue of manure. But everything possible was being done to enable any manure that was necessary to be bought by local associations which have been set up

in various places and supply the cultivators. These were the directions on which they were trying to step up the yields of fields that were being cultivated.

There was also the thorny question of the tenure of land. Insecurity of tenure, as members would agree, did not lend itself to increased and more scientific methods of agriculture for the cultivator, and he thought that a good number of them would agree with him that some action to secure for the tenant, under certain conditions, greater permanency and to restrict the extent to which he could be exploited in that direction was necessary. Therefore with that end in view, he assured them that legislation was being drafted—it was almost complete—to secure some satisfactory form of tenancy which would end in greater output. The drafting of that legislation was not a simple one. It had to be done in such a way that various loop-holes would not be there, so that the whole effect of the legislation would be nullified. For instance there was the distinction between the tenant and the actual labourer who works the paddy field. Unless it was properly drawn and drafted, that legislation could easily be evaded. Therefore the final completion was causing a certain amount of delay but he assured them that they would be able to have a more satisfactory form of tenure in the near future.

Then as regards other crops, Government has guaranteed prices for various crops under the Quotas Ordinance, to encourage the cultivator. They would agree with him that unless there was an economic incentive for growing particular crops, it was futile for the cultivator to grow anything. The Quotas Ordinance guarantees the price for certain products.

Instead of trying to spoon-feed the cultivator with subsidies of various sorts, the Government was trying to put the cultivator on his feet by forming Associations and through these associations the cultivator could strengthen and improve his agriculture and market his produce. In that direction they had tried to encourage the formation of Agricultural Products and Sales Societies wherever possible. In areas where there was surplus of produce for sale, he had found these Societies making headway, but he could not say the same with other areas. He, however, hoped to be able to see with certain modification, that may be essential, that Production and Sales Societies are introduced in other areas as well. Then, help has been rendered to the cultivator by organizing drives to create facilities for agricultural purposes. Ready means have been afforded to them to obtain various implements for cultivation purposes, and through the Co-operative movement the marketing of their produce has been organized. He emphasized that those were the measures they have adopted to try to step up food production. They have, wherever possible, tried to initiate particular drives in particular crops. He referred to two such satisfactory drives, the Maize Drive and the Mustard Drive. He added that these drives had proceeded at a very satisfactory pace and stressed the fact that they could not have a particular plan applicable to the whole country as such. The problems of each district must necessarily vary and those were the broad outlines of the policy they were pursuing. Each district within the limits of these broad outlines was to have its particular programme for that area. Members were aware that District Agricultural Committees were formed in various parts and in every district of this country. They were under the Chairmanship of the G.AA. and the A.G.AA. of the areas and he explained briefly how the officials of the District Agricultural Committees should, at their meetings, decide on the programme to be followed, and stressed that that was the machinery through which the food production programme had to be carried out in each district. He reiterated the fact that that was one of the most important problems that this country was faced with, and added that it was not only this country but that the whole world was facing this problem. He was going through some papers recently wherein

he had read that the net increase of population of the world was 56,000 a day and emphatically stated that the productivity of the land in most areas was declining. It is true that our production has increased although we had to pay more for getting a lesser quantity than we did before. Prices were increasing because of the tremendous shortage of food all over the world. The problem that faced every rice-eating country was that the population has increased since pre-war years but the land under paddy cultivation was less. That was why this country had to pay so much money for the import of rice. The recent census showed that our own population had been increasing at the rate of 100,000 every year. Looking at it in terms of paddy, it meant an extra million bushels of paddy every year for this increasing population. Looking at it in terms of land, it meant 30,000 to 40,000 acres. That was to cope with the present increase of population and therefore he thought that members would concur with him that that was a problem which was one of the most important problems that they have been called upon to face at the time, and he emphasized that unless they did tackle it within a measurable period of time, the standard of living of this country was bound to fall lower than it is. He reiterated that he was glad that they had given this subject the place it should occupy and concluded by welcoming all the members and any help and advice which they could give.

The Chairman referred to the food production programme reviewed by the Minister and said he could endorse the remarks of the Minister on the importance of the food production problem. In the discussions recently in Bangkok, the rice situation was very strongly emphasized and the picture drawn by him of rice supplies in Asia was a true one and, if anything, slightly understated. Referring to the working paper prepared by him as a basis for discussion (copies of which were circulated among members), the Chairman said that paddy occupied the chief place in it since it is the most important food crop in the Island. While he did not wish to say very much at that stage, he very briefly mentioned some of the results of the transplanting campaign which has been going on recently. A very large number of small demonstrations on cultivators' own lands had been done and the estimates of the yields of the transplanted plots and the broadcast plots were far too voluminous to quote, and he mentioned it not because those yields were abnormal but because they were fairly typical of what has been happening and showed what results could be obtained. In an area near Bandarawela, broadcast plots have been giving about 17 bushels an acre while transplanted plots have given about 44 bushels, and the seed rate of transplanting is under one bushel for an acre whereas in that area they normally broadcast about 6 bushels to an acre so that there was a saving of about 5 bushels. He compared another area in the Eastern Province where broadcast paddy gave a yield of 22 bushels whereas transplanted yielded 40 bushels. Harispattu in the Central Province produced only very low yields of 12 bushels broadcast against transplanted 40 bushels to an acre. He then referred to an area where the fields are very heavily manured where broadcast fields yielded 37 bushels to an acre while transplanted produced 57 bushels. He emphasized the effect of transplanting even on heavy yielding fields at 37 bushels to an acre and also compared the saving of seed in sowing. Out of about 27 trials carried out in the Kotmale area the average increase has been 104 per cent. In the Wanni Hatpattu, transplanted fields yielded 50 bushels while broadcast yielded only 26½. He added that in practically every area where these demonstrations have been put down, people were slowly beginning to transplant their own fields. In some areas the practice had spread a lot, in others, for one reason or another it was not spreading so fast. In some places which he recently visited, about 50 per cent. of the land has been put under transplanting in the last Maha season. The people were now beginning to realize that with proper attention, transplanting can be done with a reasonable amount of labour. He was told of a place where 80 women transplanted an acre and he wondered whether

there was standing room for 80 women in that field. The same field was now transplanted by only 8 women. The Chairman concluded with these remarks and requested the members to contribute any suggestions on the points laid down in the working paper.

Gate Mudaliyar Kariapper speaking next suggested that any plan designed for the future should be based against the background of the past and that failures as well as successes in past periods should be taken into consideration. He requested the Chairman, Minister, and members of the Board to have in their minds in the course of their deliberations, the results of their actions in the past. Mudaliyar Kariapper said he was addressing the members as one who had been connected with the Central Board of Agriculture for a considerable number of years and also as one associated with the Government of the country in the food production efforts of the country and also as a practising farmer and a villager who had just left his village about 18 hours ago. He briefly reviewed the state of the dry zone during the times of the Sinhalese Kings and said that the Director of Agriculture in the ancient days was really the King who, as a result of mature wisdom and experience, concentrated his activities mostly in the dry zone. He emphasized that in the former days hills were untouched but the mischief started about 400 years ago when foreign settlers started exploiting hills and waterways and as a result of the elimination of such forests, the flow in most of the rivers was becoming meagre and at that rate in the course of a few centuries " those rivers might cease to flow ". Consequently both vegetable and animal matter may cease to exist to the West of the Monsoon line. He offered his grateful thanks to the " young energetic Minister " for the efforts he is making to buy over useless rubber lands and he hoped most of that land would be used for re-afforestation. He reviewed the place the farmer occupied before World War I and compared the position the paddy farmer occupied during World War II, when the country became panicky over the food situation. He felt that the paddy farmer would be let down as before World War No. I and during the inter-war period. During World War II, National Food Production Campaigns were started, slogans inducing people to grow food were inscribed on walls, Food Production grants were given to the Director of Irrigation and he became one of the many agents of food production. He also added that the Chairman's predecessor was also a very keen paddy farmer. He urged that the food production campaign should be continued and hoped that the paddy industry might not be let down as in the previous periods. He emphasized that there is one magic that can step up food production and that was to guarantee the paddy farmer an economic price. He complimented the Minister that during the course of his address he had made reference to the credit facilities that had been afforded to the farmer and he hoped that in the interests of the paddy industry in the Island, a long-term guaranteed price, say for a period of 15 years, would be accepted as the magic solution to the problem of increased food production.

Rev. Fr. L. W. Wickremasinghe spoke next. He said that a majority of our paddy lands were in the areas which were cultivated by irrigation which carried the short-term 3-months variety of paddy. If yields were to be stepped up by transplanting methods, a 4-month or a 5-month variety could be grown if the Irrigation Department could allow them a 4-month crop, and provide the water. This 4-month crop could be in Maha or Yala, and he preferred if it could be allowed in Maha. This would mean the Irrigation Department having to issue water for one extra month. Vellai-Illankalayan was a good yielder and people were anxiously waiting for water. He had already cultivated and transplanted Vellai-Illankalayan because he managed to get water and he urged that that question should be tackled somehow. He felt that the only way to get more yields was to plant high-yielding, long-term paddies. He emphasized that if they could get water there was no difficulty about paddy. He concluded that even if a 5-month paddy was allowed in Maha and a 3-month paddy in Yala they would be satisfied.

Mr. Wilmot A. Perera made certain observations on matters of general interest. Apart from the question of extension of cultivation, he felt that very much more could be done by the intensification of the yields of the present areas under paddy. He wished to place before the Board the question whether sufficient effort was being made in that direction. He added that this question has been talked about for years and years. He himself had been a member of the Board for very nearly two decades. At every meeting they had had this question of paddy discussed, and he inquired whether the results achieved were commensurable with their efforts. Some years ago the Board accepted a Motion that there should be a planned and integrated programme for the intensification of yields. The question had come up again. It was undoubtedly a very complex matter. He suggested that a programme, whereby the yields of practically every bit of paddy in this country could be intensified, was very feasible, since the productivity of every area could be gauged and a target could be fixed for every season and an effort made to work up to that target. In this way he felt that if every village was brought into a district programme and a district programme into a provincial programme, then the whole Island would have a definite programme and they would know exactly where they stood and they would also know whether they were working on right lines. He felt that at present there was a diffusion of energy. He agreed that by the demonstration methods mentioned earlier a certain amount of intensification of yields was being done but he felt that the present work was not enough. Commenting on the Minister's proposal for introducing legislation regarding tenancy which he welcomed, he felt that the Thattu Maru system was definitely a draw back to the intensification of cultivation and he pointed out that in view of the rotation of ownership of paddy land in quite a large part of the country where the Thattamaru system prevailed, sometimes a cultivator gets to work the field once in 15 years. He added that the Chairman's predecessor in office had submitted a very comprehensive memorandum on that subject of consolidation of holdings, &c., and that he would like to know what decisions have been arrived at on that memorandurm.

Senator (Col.) T. Y. Wright said he was not going back to what happened 400 years ago but he would like to refer to what had happened 6 years ago. In 1943, the Administration Report of the Director of Agriculture contained proposals for increasing production which were almost identical with the proposals in the working paper tabled by the Chairman. They had considered this food production for a good many years and it was time that something was done. Mudaliyar Wickremaratne had made some really good proposals 4 years ago about utilization of Municipal and Urban Council refuse for making fertilizers for food crops and he felt that it would be a very good thing particularly for paddy fields if that suggestion could be implemented. He also believed that cultivation of paddy could be improved by the adoption of new methods if the Agricultural Department could send competent officers to direct cultivators.

Mr. R. T. Chelliah spoke next and pointed out that large areas of jungle land were cleared for food cultivation but absolutely no attention was paid to the breeding of cattle of the poor farmer either by the Government or by anybody. He emphasized that a greater extent of grazing land should be reserved for accommodating cattle. He also suggested that model farms should be opened up in various D.R.OO. Divisions to show manurial results so that people could actually see what this country was able to do and that research results must be made available to farmers. He reiterated that there were farmers in Jaffna who believed that artificial manure was injurious to the soil. He also suggested that cultivation schemes at present were under Heads of Departments or A.G.AA. and as they had far too much of work and had little time at their disposal to attend to various schemes, it was feasible if full-time officers under the Land Commissioner could be appointed for food production work and clearing new areas.

At this stage the Chairman, referring to certain points raised by Mudaliyar Kariapper, said that it was not for him to say what prices were fixed for paddy, but he felt that there was little chance of the price falling below the Rs. 8 fixed by Government, because of the great shortage of rice all over Asia.

On the question raised by Rev. Fr. Wickremasinghe, about supply of water for a 4-month paddy crop, the Chairman felt that it was a matter for the Director of Irrigation. He believed that a part of the trouble lay in cultivators not taking advantage of the early rains. They always waited till the tank was full and by that time they lose 10 or 15 inches of rainfall on their fields. He could not, however, say that it was entirely an irrigation matter, but any help they could get from the Irrigation Department was very welcome. Referring to a remark by Senator (Col.) Wright that they have been talking about food production for the last 6 years and that it was time that something was done, he emphasized that he did not think he had produced any new ideas about paddy cultivation. They all seemed to be in print in one form or another long before he came here. What had puzzled him was what prevented people from carrying them out and getting 40 bushels instead of 20 bushels. Regarding the suggestion that research results should be made available to farmers and they should be kept informed of what methods have proved most profitable, he frankly stated that he did not like the suggestion of Model Farms because from experience he had found that farmers were very indifferent to adopting new methods used on Government Farms and as such farms taught nobody. This difficulty was not peculiar to Ceylon but occurred even in England. Just outside the Rothampstead Experiment Station were found some of the worst methods of farming. The idea he advocated was small plots of very simple nature on farmers' own fields in villages, preferably near places where people could see the demonstrations when they pass to and fro. It was a very simple method using farmers' own implements if possible and own labour and sometimes their own seed. If the farmer could do without any expensive gadgets he was more likely to take to it. He also found it very effective if one could talk to the people and show the difference between his fields and the fields worked by improved methods, so that the talk spread far enough to induce the backward farmer to realize the difference.

Madawala Dissawa said that the major paddy crop of the Island came from the North-Central Province. Eastern Province, and North-Western Province, where the people do not take to transplanting because it is more expensive, and in these areas the cultivators believe in extensive cultivation rather than in intensive cultivation. In most of the fields in these areas the ploughing is so bad that the plough does not go down to the earth more than 2 inches, and the crop they get is about 6-fold. He had cultivated a field just by his house with the modern plough and had got a yield of 76 bushels. He felt that the cultivators in these areas should be taught the benefits of good cultivation and transplanting. Referring to a remark by the Minister that the population was rapidly increasing, Madawala Dissawa inquired how many cultivators have increased, since sons of these farmers who read up to the 6th or 7th standard do not like to go back to the field. At the time the paddy was sold at Rs. 1.25 per bushel and labour could not have been employed as it was not paying. According to the present price even hired labour could be employed and still get a profit if better methods of cultivation were adopted. Higher yields could be assured if only the farmer in backward areas was taught the benefits of better methods of cultivation. He was at a loss to understand why transplanting in the Central Province was done only in Maha and not during Yala. He had also observed that in the dry zone even weeding was not done. He also believed that the practice of allowing the water to drain off soon after ploughing (practice adopted in some districts) had a bad effect on the crop and the proper way was to allow sediment to settle down in the field and then drain off the water. He hoped that the Minister would see that

something was done to stop haphazard clearing of jungle which had an adverse effect on the waterways and rivers.

Mr. Clement Dias referred to certain discussions that ensued in 1943, and said that several memoranda had been drawn up on the subject but nothing had been done. He also said that there was a suggestion to get an expert on paddy from India and he was glad that Ceylon now had a permanent Director who is a Specialist in Paddy. According to Government figures there were 850,000 acres of paddy out of which 588,000 were cultivated twice a year. He emphasized the difficulties of transplanting due to regulation of water. He agreed with one of the previous speakers who suggested that a 4-months paddy and a 3-months paddy should be cultivated and the 4-months variety should be transplanted. There were 262,000 acres which carried a long-term paddy and all that could be transplanted if there were rains. Somewhere in 1930, he had started paddy cultivation as a hobby. He had advocated the transplanting method and found it difficult owing to the water being regulated. From a field of 15 acres he was getting 200 bushels of paddy but now he was getting 450 bushels from the same extent and he was sure that he could get 600 bushels by various means of improved cultivation. There were various possibilities of improving yields if people only made an attempt. They should not blame the cultivator for not adopting those methods and there were various reasons for it which he did not want to divulge at the moment. He felt that land owners (he was referring to coconut land owners) who owned paddy lands and gave their fields to villagers on a share basis whatever the extent was, either 5, 10 or 20 acres, and the villagers should be compelled to do the cultivation by the best methods. He related an incident how he first came to be interested in paddy. He had sought the help of an Instructor in 1931, who planted his land with 3 measures of paddy and he harvested a return of 486 measures. He called it a laboratory experiment. He was glad that now people in that area used the improved plough as well as pureline seed paddy. The present seed paddy he had was about 10 years old. He also used to collect the best ear-heads of paddy before harvesting which were in turn used as seed. He had another kind of small seed paddy which, from ¾ measure, he got a return of 8 bushels by transplanting. When people wanted seed paddy they asked for 15 or 20 bushels, whereas 1 measure is quite sufficient to propagate. When giving small quantities of seed paddy to people, it was far better if they could get a yaya and distribute the seed so that that yaya may contain pure seed. He believed that Vel Vidanes could do a lot to improve paddy cultivation. There are about 400 Village Committees and each Village Committee had about 20 Vel Vidanes. These Vel Vidanes were land owners and they should be asked to transplant their own lands. In Colombo District the Yala crop was always sown before the Sinhalese New Year and he felt that there should be some uniformity in sowing dates. Even the ancient Sinhalese Kings encouraged the sowing of their fields during the proper season so that by about July they used to finish their sowing just before their annual Perahera. He also felt that there was some truth in the ancient people observing the " nekhata ", because " nekhata " was the time and everything was done to time. When people spoke of food, they thought only in terms of rice. There were varieties of yams which people should be encouraged to eat, and from one acre, about 33,000 lb. of yams could be obtained. If 60,000 acres were planted with yams, he felt that as much food as the rice crops provide could be obtained. He suggested that planting of yams should be encouraged as a rotational crop. People in Ceylon consumed bulky food and some people ate rice 3 times a day in rural areas. People should be encouraged to eat more curries and less rice so that the meal becomes one of curry and rice rather than rice and curry. There were about 200 varieties of leafy vegetables which people should be encouraged to eat. They should grow vegetables like " Gotukola " in their own gardens. Planters should not cultivate only tea and rubber but a certain

amount of paddy should also be grown in low areas whereby they could be an example to the others.

Mr. W. P. A. Wickremasinghe said that in the Wet Zone, in the Southern part of this Island, the greatest impediment and the greatest obstacle to paddy cultivation was fragmentation of land. Sometimes a field of 20 or 30 acres was divided among 20 or 30 people. He knew of a paddy land of 2,000 acres which was owned by several people, so that no one person owned more than 3 or 4 acres. For 3 or 4 years this tract could not be cultivated for want of rain. Suddenly the rains came down and flooded the whole land and the ridges were broken and later on nobody cultivated this land as each owner refused to meddle with the ridges as it meant meddling with the boundaries each person owned. Fragmentation of paddy lands was a great hindrance and he requested that some means should be devised to stop it. In 1918, he had cultivated a tract of paddy land of 10 acres with Muttusamba. The seed was imported from India and the land was transplanted and the returns were a great success. He said that in the Wet Zone there was no irrigation besides inundation schemes, and if irrigation facilities were not available, the cultivators could not be induced to cultivate their fields. Cultivators as well as land owners in the Wet Zone were ready to step up production but they had to depend on rains due to lack of proper irrigation systems. He urged the Minister to see that proper irrigation facilities were provided in the Wet Zone as well, if production had to be increased. At present there were minor irrigation works managed by the G.A. or the A.G.A. of the area. Referring to a statement by the Minister that credit facilities were afforded to cultivators through societies, he inquired how the society would know a cultivator who lived 5 miles away and whether the cultivator would be able to bring a surety from such a distance who was known to the society. He felt that that system would not work properly with the poor cultivator but it was all right in the case of big land owners. He next referred to the shortage of cattle in the Wet Zone and the difficulties the cultivators experienced due to pasture lands being situated 40 or 50 miles away from the area where the biggest tracts of cultivable paddy lands existed. All along the borders of Nilvala Ganga there were about 60,000 acres of paddy within a distance of 12 or 15 miles but the pasture land was 52 miles away. This year the District Agricultural Committee and the A.G.A. were taking a lot of interest in the cultivation of fields. A large acreage of paddy was cultivated for transplanting but $\frac{3}{4}$ of it could not be transplanted due to shortage of water and lack of irrigation facilities. He emphasized that if paddy cultivation had to be improved, the District Agricultural Committees, the Agricultural Department and the Irrigation Department should work hand in hand and see that the rivers that run through the Wet Zone are harnessed and that water is stored for irrigating paddy fields.

Gate Mudaliyar Kariapper said that there was a question raised as why transplanting could not be done in the Dry Zone? The answer was that no transplanting could be done with 1 acre foot of water per acre which is available to them at present. He also endorsed the view expressed by Rev. Fr. L. W. Wickremasinghe that transplanting could not be done with 3-months paddy. He wondered whether there was a possibility of changing over to the 4-months variety. He added that in his area 30,000 acres of paddy is being cultivated with only 30,000 acre feet of water. "This performance often lands us into crop failure and distress." He said he would demand 4 freedoms from the Government on behalf of the paddy farmer, and they were—

(1) Freedom from uneconomic prices.
(2) Freedom from lack of stored water.
(3) Freedom from lack of cheap credit facilities.
(4) Freedom from lack of knowledge of scientific methods of cultivation.

He hoped that " our young Minister " would grant them these four freedoms and make Sri Lanka self-sufficient. He also added that it was his experience that when fields were sown during the waxing moon, the yields were larger by about 25 per cent. He wished if Departmental Officers could carry out investigations on this aspect of the Planetary influence.

In reply to Mr. Wickremasinghe, Mr. Taylor, the Director of Irrigation, said that irrigation works were being done in the Wet Zone as well as in the Dry Zone. Most of those gentlemen were members of District Agricultural Committees and the Irrigation Department attended to what they wanted done. The Irrigation Department was getting several jobs done in the Southern Province, but they found it difficult to get tank sites in the Wet Zone. Referring to the question of whether a 4-months paddy could be grown, he felt it was very much in the hands of the Agricultural Committees. The Department used to go on the statistics collected and there were records to show that as much as 14 acre feet of water has been used per acre of paddy. That figure was simply colossal. He reiterated that there was a lot of wastage of water. Field owners do not spend sufficient time in the field and labourers who work are not particularly interested about the issue of water. Therefore he stated that if the cultivator could spend more time in the field, he could save more water and thereby enable a bigger acreage of land to be cultivated.

The Minister suggested that it was desirable to appoint a Special Committee who could go into this matter and put forward some concrete proposals. Regarding the question of reafforestation, he agreed that it was a dire necessity. He assured the members that they would soon have an expert who has been selected as Soil Conservation Officer. He believed that most of the members were aware of an authority on Soil Conservation who visited Ceylon recently. In his book entitled the " Rape of the Earth ", it is evident that not only this country but various parts of the world were confronted with this problem of soil conservation. He was gratified to learn from Dr. Jack that our problem on soil conservation was nothing compared to the problems in most other parts of the world and he hoped it could be tackled satisfactorily. The problem in most of our paddy areas, particularly in the Wet Zone was not that there was too little water but too much water was wasted due to the water being uncontrolled and due to denudation of the catchment areas. He said that it was not possible to tackle all the rivers at the same time, but gradually it would be attended to. Regarding a request from Mudaliyar Kariapper that sufficient water should be stored for paddy cultivation, the Minister said that in Mudaliyar Kariapper's own area there was a big irrigation scheme going on, which would supply sufficient water for about 100,000 acres. He was glad that Mudaliyar Kariapper said that in his area paddy fields were cultivated with 1 acre foot of water and hoped that they would not ask for 10 or 12 acre feet once the Gal Oya Scheme was completed. The Minister said that they were proceeding to find out the resources of the Walawe Ganga and that investigations were being carried out to control the water of the Kelani Ganga and if they could prevent the floods and consequent damage which is yearly causing Government a considerable sum of money. In that manner they hoped to take river by river and utilize the full potentialities of the rivers. As emphasized by the Director, world conditions were such that a fall in the price of rice was very unlikely. Referring to a remark made by Mudaliyar Kariapper, he said he could assure Mudaliyar Kariapper that not only Communist activities in Burma but the prolific increase in population had in effect guaranteed the price of paddy.

Referring to the next question of consolidation of holdings, he endorsed the view that fragmentation of land had produced very unsatisfactory results but at the same time consolidation of holdings necessitated putting a certain number of people out of the land.

Therefore unless Government was in a position to offer them land elsewhere, they could not implement a policy of consolidation. Today their rate of opening up new land was not fast enough to cope with the demand of the landless. They had to satisfy the demands for land not only of the landless but had to attend to the needs of those who would necessarily be out of the land by consolidation.

The Minister next referred to pasture. Where land was available it was their intention at the present moment to give pasture lands over to the local authorities because somebody had to look after them if the pasture was to be utilized. In Ceylon there were about 2 million head of cattle. If they were going to depend on pasture, they should have 8 million acres of land which meant practically the whole of Ceylon being put under grass. He added that they could not think in terms of pasture alone and he hoped it should be the endeavour of everybody to grow fodder as well.

In regard to the question of water being wasted, he felt that cultivators did not make use of the rains and waited till the tanks were full. He appreciated the fears of the cultivator that his labour might go to waste and he thought that the only way to put it right was a system of crop insurance.

In reply to Mudaliyar Kariapper's request for the 4 freedoms mentioned by him, namely Freedom from uneconomic prices, Freedom from lack of stored water, Freedom from lack of cheap credit facilities, and Freedom from lack of knowledge of scientific methods of cultivation, the Minister said as regards an economic price for paddy, that a high price for paddy was a certainty with the rising demand. Regarding cheap credit facilities, the Minister said, that Credit Societies had already been started and that Mudaliyar Kariapper was the President of one. As for the lack of stored water, he emphasized that it was in Mudaliyar Kariapper's own area that one of the biggest reservoirs was being constructed. Regarding the question of the lack of knowledge of scientific methods of cultivation, the Minister said that everything possible was being done to spread such knowledge.

In reply to a remark by Mr. Wickramasinghe that these Credit Societies asked for security, the Minister said that he was not aware of such a difficulty being encountered by cultivators. At this stage Mr. S. C. Fernando, Registrar of Co-operative Societies, enlightened the members on this question and said that no security was asked for from members by Societies. The Minister added that some Societies did not work because they had too grandiose schemes. Some Societies wanted to buy tractors in places where tractors could not be used. In regard to the question of reluctance on the part of sons of farmers with an elementary education to go back to the land, a White Paper on the new policy of education would soon be out and hoped it would contain a solution to this difficulty.

In conclusion the Minister emphasized that members should not think that their suggestions were going to fall on deaf ears. He did not assure them that he would implement every one of these suggestions. There might be reasons why it was impossible to implement certain suggestions, but he would always come before them and explain why certain recommendations could not be implemented. If there were other recommendations to come in, he hoped they would appoint a Sub-Committee to go into them and make definite concrete proposals.

At this stage Senator C. A. M. de Silva inquired whether Government contemplated securing a share to the cultivator from the absentee land-owner.

The Minister replied that Government intends introducing legislation accordingly, but one particular rule for the whole Island could not work and each area had to be considered separately.

Gate Mudaliyar N. Wickremaratne spoke next. " There is one point you (the Chairman) raise in a pamphlet and that you raise here, and that is how to get the villager to do everything that is being talked here. Mudaliyar Kariapper at the beginning of his remarks said that Kings directed cultivation. Yes, they directed cultivation. And as regards the increase of population mentioned by the Minister of Agriculture and Lands, now we have to go back to the ancient history and that history has proved that the questions can be met. If you read the Mahavamsa you read about the ancient irrigation works in Ceylon. The whole Island has been one vast irrigation work. Areas were divided according to their climatic conditions and the kind of irrigation works were different to suit each locality. This irrigation work was done not only during one period but during different periods of time extending to 1,000 or 2,000 years. But today the present Minister and his predecessor have started their schemes of irrigation and colonization schemes at the same time in a bigger scale as it never happened in the history of Ceylon. During the time of those Kings our population was much higher. I will give you one instance. It is mentioned in the chronicles that the army prepared by King Parakramabahu the Great had one million 250 thousand men by selecting at 10 heads from each 100. This would show that at the time there was a population of more than ten millions.

(Referring to the working paper)—I congratulate you on your working paper, having come to this Island a year or two ago. You have mastered the situation. You have heard Mudaliyar Kariapper said that Kings directed cultivation. This is very true. King Dutugemunu directed his brother Tissa to supervise cultivation and said, " I am going to fight for the religion of the country; you better go and direct the cultivation ". He was sent to Digamadulle. We hope that Gal Oya will bring back the country to its former glory. I have some notes prepared for discussion, but I am not going to detain the house. In the olden days fields were cultivated at the proper times but during the last 30 or 40 years our seasons are changing and the cultivator does not know when he should sow. Therefore something must be done to guide the cultivator to begin work at the proper seasons. Regarding tillage, we should not blame the cultivator. The difficulty is that the land is not cultivated at the proper time and he does not know when to begin and when he begins he scratches the land and sows the seeds. What is the earthly good of purelines or manure on such lands? In the first place ploughing and tillage must be done properly. In an old reader it was recommended that the land must be ploughed, ploughed and ploughed again. That means proper tillage. Harrowing and levelling should also be introduced. In Jaffna after every shower of rain, the cultivator goes to the field and ploughs his land and in this way land is ploughed sometimes for five times. I do not think our country has any great problem about tenancy unlike in India. Mr. Wilmot Perera spoke about " Tattumaru ". What is " Tattumaru? ". If the owner has 4 children they agree to cultivate in rotation one year one, and so on. That is " Tattumaru ". Why cannot improved methods be introduced?

Mr. Wilmot A. Perera—" If it is limited to only 4, it does not matter!"

" Regarding preservation of springs, preservation of streams, &c., in the olden days there were rules that springs, ' ulpath ', could not be cleared. Those rules have disappeared. We must go back to those rules. In 1911 when I was in Kegalla as A. I., the A. G. A., went into this question and he said they could not clear the land and according to that 2 chains of land must be preserved on either sides of a stream to prevent silting.

Then, Sir, as regards seed paddy, in the first place I should like to mention that buying of seed paddy through Government Agents should be stopped. There is the Department of Agriculture and the Agricultural Officers to deal in seed paddy. What is the use of asking for purelines; how long purelines is pure? Before going to purelines ask

the cultivator to select seed paddy from whatever seed he has sown. Do not wait until you get pureline for the whole Island. The cultivator must be made to select his seed paddy from his crop. In places like Java, just before harvesting cultivators go through the paddy fields and cut good ears of paddy for seed purposes. Something like that must be done here.

Regarding Production and Sales Societies, the Co-operative Production and Sales Societies will be a thorough failure; with large areas of operation, people do not know each other in such areas. To give a bushel of paddy or a mammoty or manure to a man who lives 5 miles away without supervision will never come right. Area of operation must be limited and then you can get the villager to know each other and carry on their work of Co-operative Societies.

As regards sales of paddy, I have a word or two. There are areas of excess of production and there are deficit areas. During the time of harvesting every villager has paddy but at the time of sowing he finds he has not got even the seed paddy. Sale Societies should so arrange that they meet this situation. Removal of paddy from deficit areas should not be allowed. In the excess areas paddy bins or godowns must be built to store paddy. These societies can collect necessary statistics on paddy production in the Island. We expect things to be done without any direct authority. We have an Agricultural Department and various other Departments. The Agricultural Department have Scientific Officers who are doing excellent work in their sphere of work. We have a staff of field officers. They are going round the country and are giving advice here and advice there. They have done very little good. Your Department must be made into two different sections or branches. One scientific and the other field work. Field Officers must be specially selected for cultivation work and they must direct and supervise cultivators. Divisional Officers must be allotted to different divisions and under each Divisional Officer there must be a number of Agricultural Inspectors, Cultivation Officers, and under the Cultivation Officers the Vel Vidanes must work. The other day I read in the paper that a deputation of Vel Vidanes came to see the Minister and explain their grievances. In the olden days the King directed the cultivation, the Dissawas, Ratemahatmayas, Korales. Then the Vidane Arachchis and the Vel Vidanes attended to this work. Even during the early British period, the Government Agents, Ratemahatmayas or the Mudaliyars as they may be, Korales or Vidane Arachchis, Village Arachchis or Headmen and Vel Vidanes directed the cultivation of paddy. The Government collected 1/10th of the produce as revenue to Government. The field was made to be cultivated to obtain the ½ share. Then somebody suggested that instead of the 1/10 collected in kind, it must be converted into money payment. So the Government finally appointed Renters. They started harassing the cultivators without giving any direct assistance and as a result large number of paddy lands got into the hands of the absentee landlords. In 1887 this paddy tax was abolished. Paddy was giving 1/8th the revenue of the Island at the time. Since then paddy cultivation was neglected. To revive the paddy industry the cultivation must be directed and supervised. I appeal to the Director of Agriculture and to the Hon'ble the Minister to create a special branch of the Department under a Deputy Director or the Director himself for paddy and food production. This branch can work in co-operation with the Government Agents and Assistant Government Agents and these officers."

At this stage the Minister suggested that the discussions should be considered closed and the Board should get on with the business of appointing a Sub-committee to submit a report on the discussions for consideration by the Board.

The following Sub-committee was appointed with Mr. D. Rhind, the Director of Agriculture, as Chairman:—Madawala Dissawa, Mr. W. P. A. Wickremasinghe, M.P., Senator C. A. M. de Silva, Mudaliyar M. S. Kariapper, M.P., and Parliamentary Secretary

to the Minister of Home Affairs, T. B. Poholiyadde Dissawa, M.P., Sir J. P. Obeysekera, Mr. A. M. Clement Dias, Mr. R. T. Chelliah, the Rev. Fr. L. W. Wickremasinghe, Mr. S. A. I. Elapata, M.B.E., J.P., U.M., Mr. Wilmot A. Perera, M.P., Mr. A. Perumynar, and Gate Mudaliyar N. Wickremaratne, with the ex-officio members of the Board.

The Board agreed that the meeting of the Sub-committee should be held in Colombo at 2.30 P.M., on June 3, 1949.

The Chairman proposed a vote of thanks to the Minister for having spared his valuable time to be present at the Board Meeting. The Chairman added that the Minister's presence at the meeting was not only an encouragement to them, but he had found the Minister very helpful in the food production discussions and where agriculture was concerned.

Gate Mudaliyar Kariapper, seconding the vote of thanks, said that he wished to express the sentiments of the house in regard to the valuable discussions they have had with the Minister. In his concluding remarks, he said that at first they thought that the Prime Minister's greatest gift to Ceylon was improvement of Agriculture. Later they changed their minds and thought that his greatest gift was securing Independence to Ceylon. But now they felt that his greatest gift to the Island was neither of those but his son as Minister of Agriculture.

The meeting terminated at 5.30 p.m.

H. E. S. RANASINGHE,
Secretary,
Central Board of Agriculture.

Peradeniya, June 26, 1949.

Rubber Research Scheme (Ceylon)

MINUTES OF THE NINETY-THIRD MEETING OF THE RUBBER RESEARCH BOARD HELD AT THE PLANTERS' ASSOCIATION HEADQUARTERS, COLOMBO, AT 10 A.M. ON SATURDAY, AUGUST 6, 1949

Present.—Mr. D. Rhind, O. B. E. (Director of Agriculture) in the chair, Dr. E. Phillis (Director, R. R. S.). Mr. H. E. Peries, C. C. S. (Acting Deputy Secretary to the Treasury), Major Montague Jayawickrama, M. P., Mr. F. A. Obeyesekera, and Mr. J. L. D. Peiris.

Apologies for absence were received from Messrs. H. St. J. Cole Bowen and F. H. Griffith, M. P.

Dr. H. E. Young, Oidium Research Officer, was present by invitation.

1. MINUTES

(*a*) *Signing.*—Draft minutes of the meeting held on May 23, 1949, which had been circulated to members, were signed by the Chairman on signification of members' assent that they were in order.

(*b*) *Matters arising from the minutes.*—

Chemist.—Noted that Mr. M. W. Philpott had declined to accept the post of Chemist. Agreed that the post be re-advertised.

Major M. Jayawickrama came into the meeting at this stage.

2. BOARD

The Chairman reported that :—

(*a*) Senator. C. Wijesinghe had been nominated to represent the Senate with effect from April 16, 1949, in place of Senator U. A. Jayasundera, K. C., who had resigned.

(*b*) Mr. F. H. Griffith, M. P., had returned to the Island and resumed his seat as a representative of the Planters' Association of Ceylon, with effect from July 25, 1949, relieving Mr. R. C. L. Notley who had been acting for him.

(*c*) Mr. H. E. Peries, C. C. S., had been deputed to represent the Minister of Finance with effect from July 29, 1949, during the absence of Mr. T. D. Perera, C. C. S., from the Island.

3. STAFF

(*a*) *Director.*—The Chairman reported that Dr. E. Phillis had arrived in Ceylon and assumed duties on June 22.

(*b*) *Oidium Research Officer.*—Reported that Dr. H. E. Young had arrived in Ceylon and assumed duties on July 11.

(*c*) *Junior Staff.*—Changes in junior staff since the last meeting were reported.

4. REPORTS AND ACCOUNTS

(*a*) *Statement of Receipts and Payments for the 1st quarter 1949*—was approved.

(*b*) *Estate accounts January to March, 1949*—were tabled.

(*c*) *Investments.*—Reported that Rs. 250,000 had been invested in 3 per cent. Sri Lanka Government Loan 1969/74.

(*d*) *Labourers' wages.*—Noted that the wages of labourers on the Scheme's estates had not been reduced.

5. LONDON ADVISORY COMMITTEE FOR RUBBER RESEARCH (CEYLON AND MALAYA)

(*a*) *Ceylon representative.*—A letter from the Permanent Secretary to the Minister of Agriculture and Lands stating that Mr. E. W. Whitelaw had been nominated to the Committee as Ceylon's representative was read.

(*b*) *Minutes of meetings of the Committee and the Technical Sub-Committee held on March 25, 1949*—were tabled.

6. PUBLICATIONS

Advisory Circular No. 27 was tabled.

7. EQUIPMENT FOR OIDIUM RESEARCH OFFICER

Agreed that orders for certain special items of equipment required for microscopic and field work by the Oidium Research Officer be placed as soon as possible.

8. NEXT MEETING

Agreed that the next meeting be held at 2.30 p.m. on September 23, 1949.

The meeting then terminated.

Dartonfield,
Agalawatta, August 13, 1949.

C. D. DE FONSEKA,
Secretary-Accountant.

Rubber Research Scheme (Ceylon)

MINUTES OF THE NINETY-FOURTH MEETING OF THE RUBBER RESEARCH BOARD HELD AT THE PLANTERS' ASSOCIATION HEADQUARTERS, COLOMBO, AT 2.30 P.M. ON FRIDAY, SEPTEMBER 23, 1949

Present.—Mr. D. Rhind, O.B.E. (in the Chair), Dr. E. Phillis (Director, R. R. S.), Mr. T. D. Perera, C.C.S. (Deputy Secretary to the Treasury), Mr. H. St. J. Cole Bowen, Mr. F. H. Griffith, M.P., Mr. F. A. Obeyesekera, Mr. J. L. D. Peiris, and Senator C. Wijesinghe.

A letter was received from Mr. F. Amarasuriya regretting his inability to attend the meeting owing to illness.

1. MINUTES

(*a*) *Signing.*—Draft minutes of the meeting held on August 6, 1949, which had been circulated to members, were signed by the Chairman on signification of members' assent that they were in order.

(*b*) *Matters arising from the minutes.*—

Experimental Committee.—Agreed that an Experimental Committee be appointed consisting of the Director, one member of the Board, and three leading Visiting Agents.

2. BOARD

The Chairman reported that Mr. T. D. Perera, C.C.S. (Deputy Secretary to the Treasury) had returned to the Island and resumed his seat with effect from August 29, 1949, relieving Mr. H. E. Peries, C.C.S., who had been acting for him.

3. REPORTS AND ACCOUNTS

(*a*) *Director's Report for the 2nd quarter 1949*—was approved.

(*b*) *Auditor-General's Report and Balance Sheet, &c., for 1948*—were adopted.

(*c*) *Inventory Report for 1948*—was adopted.

(*d*) *Statement of Receipts and Payments for the 2nd quarter 1948*—was approved.

(*e*) *Estate Accounts April to June 1949*—were tabled.

(*f*) *Revote of balances of 1948 capital votes*—Balances of 1948 capital votes for 1948 amounting to Rs. 88,587 were re-voted.

4. STAFF

Changes in junior staff since the last meeting were reported.

5. LONDON ADVISORY COMMITTEE—MINUTES OF MEETINGS OF THE COMMITTEE AND THE TECHNICAL SUB-COMMITTEE HELD ON JULY 8, 1949—were tabled.

6. CIRCULAR LETTER ON SYNTHETIC RUBBER—was tabled.

7. REPORT ON DIRECTOR'S VISIT TO MALAYA

The Chairman reported that the Director had represented the Scheme at the Conference of Rubber Research Organizations in the East which had been held in Malaya recently. His report, which had been circulated to members, was considered and it was noted that the main subject discussed at the Conference was the improvement in the quality of natural rubber by the preparation of rubber of uniform quality and by the introduction of a system of grading based on its technological properties. The Director emphasized the need for immediate action to ensure the production of rubber of uniform quality in Ceylon. Other countries had already taken action and Ceylon should not lag behind if her share of the industry is to be retained. He visualised the establishment of large central factories for collection and bulking of latex which would be scientifically tested for technical quality. This would eliminate the present unsatisfactory arrangement of buying rubber by appearance as this gives no indication of the physical properties of the rubber. After discussion it was agreed that the attention of the Government be drawn to this matter.

8. EXCHANGE OF CLONES WITH THE RUBBER RESEARCH INSTITUTE OF MALAYA

Members agreed with the principle of exchange and the arrangements for exchange were left in the hands of the Directors of the two institutions.

9. VISIT TO DARTONFIELD

Agreed that members should hold a meeting at Dartonfield on October 22, for a discussion on matters pertaining to the work of the Scheme.

The meeting then terminated with a vote of thanks to the Chair.

Dartonfield,
Agalawatta, October 6, 1949.

C. D. DE FONSEKA,
Secretary-Accountant.

ANIMAL DISEASE RETURN FOR THE MONTH ENDED JULY 31, 1949

Province	Disease	Fresh cases during the month	Cases up to date since Jan. 1, 1949	From Jan. 1, 1949, to July 31, 1949			
				Deaths	Recoveries	Balance ill	No. shot
Western Province	Foot-and-mouth	368	687	8	423	256	—
	Rabies	—	1	1	—	—	—
Colombo Municipality	Foot-and-mouth	30	327	—	297	30	—
	Rabies	4	39	39	—	—	—
Cattle Quarantine Station	Anthrax in (sheep & goats)	5	74	74	—	—	—
	Foot-and-mouth	—	12	—	12	—	—
Northern Province	Anthrax	190	385	378	7	—	—
	Foot-and-mouth	92	883	21	720	142	—
	Rabies	1	2	2	—	—	—
	Black Quarter	—	17	17	—	—	—
North-Central Province	Foot-and-mouth	277	2,392	2	2,113	277	—
North-Western Province	Foot-and-mouth	298	4,970	321	4,612	37	—
Central Province	Foot-and-mouth	25	464	—	431	32	1
	Rabies	—	8	8	—	—	—
	Piroplasmosis	—	1	—	1	—	—
Sabaragamuwa Province	Piroplasmosis	—	10	3	7	—	—
	Rabies	1	2	—	—	—	2
Uva Province	Rabies	—	1	1	—	—	—
Eastern Province	Black Quarter	12	12	12	—	—	—
Southern Province	Rabies	1	9	1	—	—	8

Peradeniya, January 5, 1950.

P. G. MALKANI,
Acting Deputy Director (Animal Husbandry),
and Government Veterinary Surgeon.

ANIMAL DISEASE RETURN FOR THE MONTH ENDED AUGUST 31, 1949

Province	Disease	Fresh cases during the month	Cases up to date since Jan. 1, 1949	From Jan. 1, 1949, to Aug. 31, 1949			
				Deaths	Recoveries	Balance Ill	No. Shot
Western Province	Foot-and-mouth	296	983	8	846	129	—
	Rabies	—	1	1	—	—	—
Colombo Municipality	Foot-and mouth	—	327	—	327	—	—
	Rabies	2	41	41	—	—	—
Quarantine Station	Anthrax	6	80	80	—	—	—
	Foot-and-mouth	—	12	12	—	—	—
Northern Province	Anthrax	—	385	378	7	—	—
	Foot-and-mouth	23	906	21	838	47	—
	Rabies	—	2	2	—	—	—
	Black Quarter	—	17	17	—	—	—
North-Central Province	Foot-and-mouth	35	2,427	2	2,390	35	—
North-Western Province	Foot-and-mouth	116	5,086	321	4,710	55	—
Central Province	Rabies	—	8	9	—	—	—
	Piroplasmosis	1	2	—	2	—	—
	Foot-and-mouth	36	500	—	463	36	1
Sabaragamuwa Province	Piroplasmosis	—	10	3	7	—	—
	Rabies	3	5	1	—	—	4
Uva Province	Rabies	—	1	1	—	—	—
Eastern Province	Black Quarter	—	12	12	—	—	—
Southern Province	Rabies	—	9	1	—	—	9

P. G. MALKANI,
Acting Deputy Director (Animal Husbandry)
and Government Veterinary Surgeon.

Peradeniya, January 5, 1950.

3——J. N. A 94258 (12/49)

ANIMAL DISEASE RETURN FOR THE MONTH ENDED SEPTEMBER 30, 1949

Province	Disease	Fresh cases during the month	Cases up to date since Jan. 1, 1949	From Jan. 1, 1949, to Sept. 30, 1949			
				Deaths	Recoveries	Balance Ill	No. Shot
Western Province	Foot-and-mouth	24	1,007	8	976	23	—
	Rabies	—	1	1	—	—	—
	Piroplasmosis	1	1	1	—	—	—
Colombo Municipality	Foot-and-mouth	—	327	—	327	—	—
	Rabies	8	49	49	—	—	—
Quarantine Station	Anthrax in (sheep & goats)	3	83	83	—	—	—
	Foot-and-mouth	—	12	12	—	—	—
Northern Province	Foot-and-mouth	14	920	18	888	14	—
	Anthrax	—	385	378	7	—	—
	Rabies	—	2	2	—	—	—
	Black Quarter	—	17	17	—	—	—
North-Central Province	Foot-and-mouth	—	2,427	2	2,425	—	—
North-Western Province	Foot-and-mouth	22	5,108	322	4,779	7	—
Central Province	Mange (cattle)	98	98	—	—	98	—
	Rabies	—	8	—	—	—	—
	Piroplasmosis	—	2	—	2	—	—
	Foot-and-mouth	—	500	—	499	—	1
Sabaragamuwa Province	Piroplasmosis	—	10	3	7	—	—
	Rabies	1	6	2	—	—	4
Uva Province	Rabies	—	1	1	—	—	—
	Black Quarter	8	8	8	—	—	—
Eastern Province	Black Quarter	—	12	12	—	—	—
Southern Province	Rabies	1	10	1	—	—	9

P. G. MALKANI,
Acting Deputy Director (Animal Husbandry)
and Government Veterinary Surgeon

Peradeniya, January 5, 1950.

METEOROLOGICAL REPORT, JULY, 1949

STATION	TEMPERATURE				HUMIDITY		Amount of Cloud	RAINFALL		
	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Minimum)		Amount	No. of Rainy Days	Offset
	°	°	°	°	%	%		Ins.		Ins.
Agalawatta	85·2	+0·1	72·8	—0·9	85	98	7·0	12·89	26	+ 0·19
Anuradhapura	91·1	+0·2	75·6	—0·4	66	88	6·2	1·69	7	+ 0·37
Badulla	85·6	—0·8	65·4	+1·3	71	95	6·4	3·66	13	+ 1·49
Batticaloa	90·7	—1·6	76·8	—0·2	70	82	6·4	1·24	6	+ 0·20
Colombo	85·2	+0·4	75·8	—1·3	84	93	6·6	6·53	25	+ 1·04
Diyatalawa	76·6	—1·6	62·8	—0·2	72	84	6·8	4·28	16	+ 2·32
Galle	83·6	+0·8	77·1	—0·2	83	86	6·4	6·28	22	— 0·06
Hakgala	69·0	+0·8	58·0	—0·5	86	89	6·8	5·51	15	— 1·13
Hambantota	85·8	—1·8	76·3	0	82	88	6·1	4·54	14	+ 2·53
Jaffna	86·8	+0·7	80·4	+0·6	76	82	5·6	0·21	2	— 0·34
Kandy	83·2	+0·4	70·5	—0·2	78	87	6·8	14·75	27	+ 7·43
Kurunegala	86·0	—0·4	74·8	—0·5	75	84	5·6	8·20	28	+ 4·32
Lunuwila	85·0	—0·2	76·0	—1·0	83	91	6·1	7·23	27	+ 3·21
Mannar	87·6	+0·1	79·6	+0·4	78	82	6·4	1·37	1	+ 1·02
Nuwara Eliya	66·0	+0·7	55·0	+0·2	86	88	7·4	8·35	27	— 2·67
Puttalam	87·2	+1·3	78·4	0	76	84	6·0	0·54	4	— 0·45
Ratnapura	86·6	0	73·9	—0·7	83	95	6·7	18·24	28	+ 5·47
Talawakele	71·6	+1·4	59·2	—0·3	82	89	6·9	11·16	28	— 2·14
Trincomalee	91·8	—0·7	77·7	—0·4	68	82	6·5	4·47	6	— 2·74

South-west monsoon weather prevailed over most of July too, and the rainfall was again chiefly confined to the south-western parts, the windward slopes of the hills experiencing rain nearly every day. Several stations here recorded monthly totals over 25 inches, the highest being 35·06 inches at Kellie Estate, 31·68 inches at Watawala 31·55 inches at Theydon Bois Group, 31·18 inches at Norton Bridge and 30·21 inches at Arslena Estate. Elsewhere in the south-west the monthly totals were less, coastal areas receiving only 5 to 10 inches. Even here an interesting feature was the frequency of occurrence of precipitation through the month. Thus, at Colombo, rainfall was experienced on 27 days as against an average of 15 days, while the corresponding figures for Ragama (Orange Hill Estate) and Bentota (Kanana Estate) were 28 and 26, against averages of 15 and 19 respectively.

In the south-east quarter the monthly totals generally ranged from 2 to 5 inches, higher amounts, however, occurring at the hill stations. In the north the rainfall was mainly below two inches, a small area to south of Mannar receiving no rain at all.

Rainfall in July was above normal over a major portion of the Island. The larger excesses (of the order of 5 to 10 inches) occurred in the Province of Sabaragamuwa and in Kandy District, outstanding positive departures from average being 14·66 inches at Pindeniya, 13·93 inches at Diwela Estate, 13·86 inches at Gampola and 13·58 inches at Kellie Estate. Deficits were generally small, and occurred in the north-central parts and in limited areas in the south-western coastal regions and Nuwara Eliya District. The biggest shortfalls were 4·30 inches at Hatton Police Station and 4·07 inches at Abergeldie Group.

The weather was disturbed for a short period from 17th to 20th, when a low pressure area moved across the Island. During these days fairly widespread thunder activity was experienced, and hailstorms were reported from Nuwara Eliya on the 17th, Kolonna on the 18th and Gampola on the 19th.

There were two days of considerably heavy rain, the 23rd and 28th, when several stations int he south-west recorded daily amounts over 5 inches, the highest being 8·60 inches at Pelmadulla and 7·40 inches at Maliboda Estate, both on the 28th. Altogether 35 such falls were registered during the month.

Day temperatures were below normal on the east side of the Island and a little above normal elsewhere while night temperatures were on the whole about average. The highest shade temperature for the month was 96·8° at Batticaloa on the 26th, while the lowest temperature was 47·0° at Nuwara Eliya on the 18th. Humidities and cloud amounts were above average. The wind strength was slightly below the normal value, the prevailing direction being south-westerly.

D. T. E. DASSANAYAKE,
Superintendent Observatory.

4——J. N .A 94258(12/49)

METEOROLOGICAL REPORT, AUGUST, 1949

STATION	TEMPERATURE				HUMIDITY		Amount of Cloud	RAINFALL		
	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Minimum)		Amount	No. of Rainy Days	Offset
	°	°	°	°	%	%		Ins.		Ins.
Agalawatta	85·3	+0·3	73·2	—0·3	90	98	7·3	23·81	28	+12·77
Anuradhapura	91·1	—0·2	75·7	+0·2	70	91	6·5	2·93	10	+ 1·31
Badulla	84·4	—1·7	65·2	+0·8	72	95	6·2	12·11	14	+ 8·91
Batticaloa	89·2	—1·4	76·5	—0·1	72	82	6·6	4·18	10	+ 2·23
Colombo	85·2	+0·4	77·7	+0·8	82	89	6·5	4·82	19	+ 0·79
Diyatalawa	76·9	—1·0	61·5	—0·3	72	86	6·5	5·18	14	+ 2·06
Galle	83·0	+0·4	77·3	+0·6	83	86	6·9	10·18	24	+ 4·04
Hakgala	69·5	+0.4	58·1	+0·7	84	89	6·5	5·28	10	+ 0·13
Hambantota	84·9	—2·0	76.1	0	82	91	6·5	1·52	11	+ 0·08
Jaffna	87·2	+1·2	80·0	+0·8	76	82	6·3	4·28	7	+ 3·17
Kandy	84·2	+1·1	70·4	+0·3	76	90	6·2	7·97	21	+ 2·24
Kurunegala	86·0	—0·9	75·1	+0·3	73	84	5·8	7·56	18	+ 3·94
Lunuwila	84·9	—0·2	77·0	+0·2	—	—	—	4·53	14	+ 1·34
Mannar	87·8	+0·4	79·2	+0·6	77	85	6·6	0·80	4	+ 0·14
Nuwara Eliya	66·6	+0·6	54·7	+0·4	84	91	7·0	7·80	22	+ 0·29
Puttalam	87·5	+1·2	78·2	+0·3	76	86	6·3	1·82	6	+ 1·17
Ratnapura	87·2	+0·6	74·4	+0·2	82	95	6·8	31·30	25	+19·91
Talawakele	71·7	+0·8	59·1	—0·1	87	94	6·6	9·55	24	— 0·53
Trincomalee	91·1	—1·0	76·7	—0·6	69	84	6·8	5·69	10	+ 2·08

The main feature of the weather in August was the occurrence of heavy rain inland in the south-west quarter on the 26th resulting in floods at several places in this area. The rainfall on that day was fairly widespread over the Island, but the larger falls were confined to a narrow north-westerly strip of land extending roughly from Rakwana to Dandagamuwa, where as many as 46 stations recorded amounts over 5 inches. Heaviest rain was centred round Ratnapura, 5 stations recording falls over 10 inches, the highest being 13·07 inches at Hallayen Estate and 13·01 inches at Ratnapura. Altogether 79 daily falls over 5 inches were recorded in August.

In the south-western foot-hills and the adjacent mid-country, appreciably heavy falls were also experienced in places on the 18th, 22nd and 30th, and monthly totals there were consequently high. Several stations totalled over 25 inches for the month, the highest being 42·76 inches at Gonapenigala Estate, 35·05 inches at Hallayen Estate, 34·74 inches at Maliboda Estate and 33·00 inches at Keragala Estate.

Outside this area there was a gradual decrease in rainfall, and totals at the south-western coastal stations were below 10 inches. In the north and east the monthly rainfall was generally below 5 inches. Least rain was experienced along the north-west coast and in the neighbourhood of Hambantota, where the monthly aggregates were below 2 inches.

Rainfall for the month was above normal practically over the whole Island, excesses in the south-western foot-hills and the adjacent mid-country being exceptionally large. Thus at Gonapenigala, Hallayen, Digalla and Dunedin, the excesses were 28·83, 23·03, 20·94 and 18·45 inches respectively, the monthly totals being about three times the average. There were also comparatively large excesses in Badulla District. The only appreciable deficits occurred in a limited area in the neighbourhood of Hatton, e.g., 5·87 inches at Dimbula, 5·35 inches and Blair Athol Estate and 3·38 inches at South Wanarajah Estate.

Day temperatures were below normal on the east side of the Island and generally above normal elsewhere, while night temperatures were on the whole a little above normal. The highest shade temperature for the month was 96·8° at Batticaloa on the 14th and the lowest temperature 48·3° at Nuwara Eliya on the 6th. Humidities and cloud amounts were above average. The wind strength was below the normal value, the prevailing direction being south-westerly.

D. T. E. DASSANAYAKE,
Superintendent Observatory.

METEOROLOGICAL REPORT, SEPTEMBER, 1949

STATION	TEMPERATURE				HUMIDITY		Amount of Cloud	RAINFALL		
	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Minimum)		Amount	No. of Rainy Days	Offset
	°	°	°	°	%	%		Ins.		Ins.
Agalawatta	85·7	+0·2	73·1	0	89	98	7·0	10·97	25	—4·39
Anuradhapura	91·6	0	76·1	+1·0	64	88	6·2	0·03	2	—3·73
Badulla	84·6	—1·1	65·3	+1·1	70	95	6·0	2·62	9	—1·87
Batticaloa	89·6	—0·2	76·4	+0·2	72	84	6·4	3·01	9	+0·62
Colombo	85·7	+0·4	78·1	+1·5	78	86	6·2	3·04	18	—3·80
Diyatalawa	76·8	—1·1	62·9	+2·0	68	78	6·6	3·94	11	—0·47
Galle	83·0	+0·1	76·7	—0·1	83	86	6·4	6·84	23	—1·97
Hakgala	67·6	—2·4	57·8	+1·0	84	89	7·0	5·08	13	—1·58
Hambantota	85·4	—1·2	76·0	—0·1	82	91	6·8	1·32	11	—1·44
Jaffna	85·8	—0·4	79·9	+0·7	77	82	6·2	2·72	3	+0·19
Kandy	83·1	—1·3	70·7	+1·5	78	87	6·7	5·65	20	—0·79
Kurunegala	86·2	—1·5	75·1	+0·8	71	82	6·4	2·30	20	—3·25
Lunuwila	84·9	—1·1	77·1	+0·9	—	89	—	2·94	13	—2·36
Mannar	87·3	—0·4	79·6	+0·9	77	82	6·4	0	0	—1·24
Nuwara Eliya	65·5	—1·4	55·1	+2·0	84	88	7·2	7·07	25	—1·17
Puttalam	86·5	—0·3	78·6	+0·7	76	84	6·4	0·50	2	—1·08
Ratnapura	86·7	—0·4	74·4	+0·9	82	93	6·2	11·90	25	—2·62
Talawakele	71·0	—1·3	59·6	+1·3	87	91	7·1	8·28	25	—1·47
Trincomalee	92·6	+0·6	77·7	+0·7	60	80	6·2	3·39	3	—0·04

For the third successive year the rainfall over the Island was below normal in September. The largest deficits (of the order of 5 to 10 inches) occurred inland in the south-west quarter in the neighbourhood of Labugama, Carney Estate recording 10·25 inches below average. Other large deficits were 8·66 inches at Hapugastenne Estate, 8·25 inches at Dompe and 8·10 inches at Hanwella. Deficits among the central hills, and in the north and south-east of the Island, were mainly below 2 inches. Slight excesses occurred in a few isolated areas, notably in the Namunukula hills. The greatest excesses were 4·77 inches at Pooprassie Estate, 4·49 inches at Kehellandewewa and 3·97 inches at Doragalla Estate.

Rainfall was generally heaviest on the south-western slopes of the hills around Watawala, where several stations recorded totals over 15 inches, e.g., 23·27 inches at Theydon Bois Group, 22·39 inches at Norton Bridge, 20·21 inches at Weweltalawa Estate, 19·80 inches at Watawala and 18·92 inches at Kenilworth Estate. Gonapenigala Estate in Kalawana District, 91·50 recorded a high total 22·94 inches for the month. Outside this area there was a gradual decrease in rainfall and monthly totals at the south-western coastal stations amounted to about 5 inches. In the northern half of the Island and in the south-east the monthly totals were generally less than two inches. Several stations chiefly in the north-central Province and in the neighbourhood of Mannar, received no rain at all.

There were no daily falls of five inches and over.

Monsoon weather with moderate south-westerly winds prevailed over most of the month. A temporary strengthening of the monsoon conditions resulted in squally weather on the 13th and 14th. Monsoon was weak during the last four days, when evening thunder activity developed on the east side, resulting in a fair amount of rain on the 29th and 30th. This rain was accompanied by hail at Diyatalawa on the 29th, and at Pattipola on the 30th.

Temperatures were mainly below normal by day, and above normal by night. The highest shade temperature for the month was 97·8° at Trincomalee on the 27th. The lowest temperature for low country stations was 71·0°at Agalawatta on the first, while the lowest temperature recorded was 50·6° at Nuwara Eliya on the 29th. Humidities were above average by day and below average by night. The skies were more cloudy than usual.

D. T. E. DASSANAYAKE,
Director.

6. Confectionery and Icecream News (Issued to Girls' Farm School, Kundasale).
7. Czechoslovakia Academy of Agriculture—Annals.
8. Dominion Department of Agriculture—Marketing Service Publications.
9. Farmers Weekly.
10. Gazeta Do Agriculture.
11. India Central Manure (Compost) Development Committee Proceedings.
12. Indian Coffee Board Monthly Bulletin.
13. Indian Dairyman.
14. Indian Journal of Dairy Science.
15. *INEAC*—Essences Forestieres *et* Bois Du Congo.
16. Laundry Journal (Issued to Girls' Farm School, Kundasale).
17. Laundry Record (Issued to Girls' Farm School, Kundasale).
18. The North American Veterinarian (Issued to V. R. O.).
19. Ontario Department of Agriculture—Statistics and Publications Branch Bulletins.
20. Puerto Rico Federal Experiment Station Bulletins.
21. Rubber Research Scheme Ceylon Circulars.
22. Scotland Department of Agriculture Advisory Leaflets New Series.
23. Soil Science Society of Phillipines Journal.
24. Stichcraft (Issued to Girls' Farm School, Kundasale).
25. St. Helena Department of Agriculture and Forestry Annual Reports.
26. World Crops.
27. Wye College Occasional Publications.
28. Wye College Reprints—New Services.

List of New Acquisitions to the Library, Department of Agriculture, for the Period, July 1, 1949 to September 30, 1949

BOOKS

1. Engler and Prantl—Der Naturlichen Pflanzenfamilien—Band 14e. (issued to A. S. B.).
2. Dykstra, R. R.—Animal Sanitation and Disease Control, Revised Edition (issued to V. R. O.).
3. Anderson, E.—The Corn Plant of Today.
4. Murray, R. K. S.—Diseases of Rubber in Ceylon.
5. Pieris, W. V. D Illustrated Guide to Coconuts.
6. Garner, W. L.—The Production of Tobacco.
7. Smith, K. M.—Virus Diseases of Farm and Garden Crops (issued to Patho).
8. Schmidt, Henry, *et al.*—Farm Enterprises Mechanics (Revised Edition).
9. The work of the F. A. O. 1947/48.
10. Tweed—Poultry Keeping in India, 8th Edition.
11. Bronkhurst, J. J.—Poultry Farming, 2nd Edition.
12. Davies, O. L.—Statistical Methods in Research and Production, 2nd Edition.
13. Piper, G. V.—Forage Plants and their Culture, Revised Edition.
14. Fisher, R. A.—The Design of Experiments, 5th Edition.
15. Wilson, R. F.—Horticulture Colour Chart Parts I and II, Revised Edition.
16. Bhatnagar, Chopra, *et al.*—The Wealth of India—Raw Materials, Vol. I.
17. Bhatnagar Chopra, *et al.*—The Wealth of India—Industrial Products, Vol. I.
18. Gruneberg—Animal Genetics and Medicine. (Issued to D. A. O., Bandarawela.)
19. Coffey and Jackson.—Livestock Management. (Issued to D. A. O. Bandarawela.)
20. Bennet, H. H.—Soil Conservation. (Issued to A. R. O., Maha Illuppallama.)
21. U. S. D. A., Year Book of Agriculture 1938. (Issued to D. A. O., Bandarawela.)
22. Ferguson's Ceylon Directory 1949. (Issued to Principal, School of Agriculture, Peradeniya.)
23. Macmillan, H. F.—Tropical Planting and Gardening, 5th Edition. (Issued to Principal, School of Agriculture, Peradeniya.)
24. F. A. O. Yearbook of Food and Agricultural Statistics 1948.
25. Lanerole—English Sinhalese Dictionary, Vol. I. (Issued to Propaganda Officer).
26. Soysa—English Sinhalese Dictionary (Issued to Propaganda Officer).
27. Freedom Souvenir of the U. N. P. (Issued to Propaganda Officer).
28. Zoysa, A. P. de.—English Sinhalese Dictionary (Issued to D. A. O., Peradeniya).
29. Ferguson's Ceylon Directory 1949 (Issued to D. A. O., Peradeniya).
30. Malherbe, I. V.—Soil Fertility, 6th Edition (Issued to A. R. O., Maha Illuppallama).
31. Smith, W. W.—Pork Production (Revised Edition).
32. Jasny, N.—Research Methods on the Farm Use of Tractors.
33. Forster, G. W.—Farm Organization and Management, Revised Edition.
34. Ceylon Administration Reports, 1946.
35. Vogt, W.—Road to Survival (Issued to D. A. O., Bandarawela).
36. Huxley, J.—Evolution the Modern Synthesis (Issued to Farm School, Kundasale).
37. Atack and Hope—The Chemist's Yearbook 1949 (Issued to Farm School, Kundasale).
38. Corrie, F. E.—Lime in Agriculture (Issued to Farm School, Kundasale).
39. Dakin, W. J.—The Elements of Animal Biology (Issued to Farm School, Kundasale).
40. Marshall and Hurst—A Junior Course of Practical Zoology, 11th Edition (Issued to Farm School, Kundasale).
41. Borradaile, L. A.—A Manual of Elementary Zoology, 11th Edition (Issued to Farm School, Kundasale).
42. Jayawardena, J. R.—A Full Employment Policy.
43. The Colonial Office List, 1949.
44. Yegna Narayan Iyer—Field Crops of India, 2nd Edition.
45. Mc Donald, J.—Cyprus Agriculture 1938–48.
46. Birtwistle, V.—Duck Keeping for Pleasure and Profit.
47. Yapp, W. B.—An Introduction to Animal Physiology (Issued to Farm School, Kundasale).
48. Dakin, W. J.—The Elements of General Zoology, 3rd Edition (Issued to Farm School, Kundasale).
49. Henderson, W. M.—The Quantitative Study of Foot and Mouth Disease Virus.
50. Israelson, O. W.—Irrigation Principles and Practice.
51. Wadia, D. N.—Mineralogy Dept. Professional Papers I and II (Issued to Girls' Farm School, Kundasale).
52. Malherbe, I. de V.—Soil Fertility, 6th Edition (Issued to A. R. O., Hambantota).
53. Fisher, R. A.—Statistical Methods for Research Workers, 10th Edition (Issued to A. R. O., Hambantota).

PERIODICALS

1. American Newsfile Agriculture Supplement.
2. Board of Agriculture and Animal Husbandry in India—Animal Husbandry Wing—Proceedings.
3. Canada Dominion Bureau of Statistics. Agricultural Division Monthly Review.
4. Caravan and Trade Journal.
5. Colony of Singapore Annual Reports.